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Build Addition Planned Decade Ago

Manufacturer of Stoves and Heating Equipment Develops Plant To Handle Increased Output—Great Variety Shown in Castings Produced and Practice Followed

BY HERBERT R. SIMONDS

EASTERN New England long has been a prominent district for the manufacture of stoves. Massachusetts alone has 10 large stove manufacturing plants, in addition to several smaller ones. Historically, there is no stovemaking section with as great interest. Moldenke in his *Principles of Iron Founding* speaks of a Mr. Pratt who was a Massachusetts foundryman and stove manufacturer in 1819, and says that the present Walker & Pratt foundry at Watertown, Mass., may be traced back through the years to the work and ancestry of the Pratt of 100 years ago.

Recently attention has been directed to the Watertown stove foundry through the construction of two new buildings at a time when any industrial building has aroused interest. The two buildings which have just been completed form extensions to an already large plant which was designed and built over 20 years ago. One of the new buildings is a 122 x 160-foot extension to the main foundry floor, bringing the total floor length to 560 feet, with a uniform width of 122 feet. The other building houses a new sheet metal working department.

Several points are of more than passing interest in connection with this new construction. One is the fact that both buildings form part of the original plan of 20 years ago, and that the growth of the concern was at that time predicted along lines approximating those

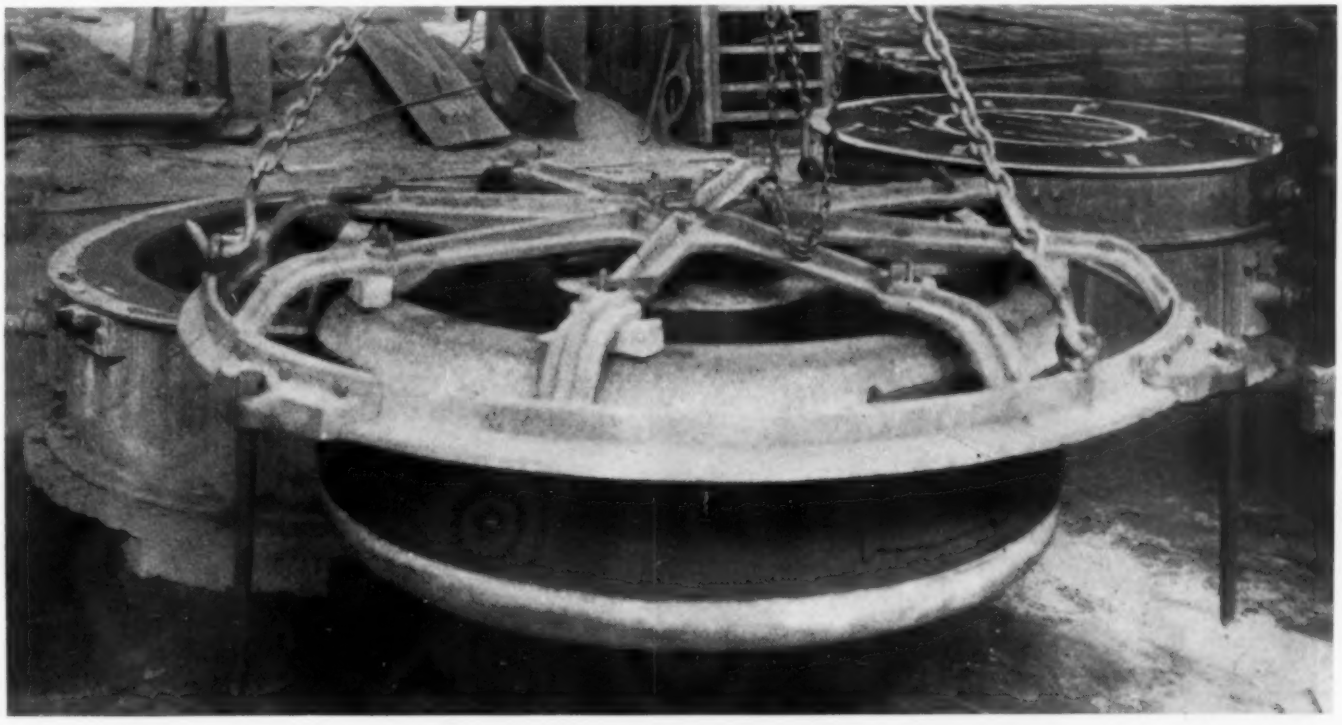

FIG. 1—AN UNUSUAL CORE CONSTRUCTION WHERE GREEN SAND IS USED BETWEEN TWO RINGS OF DRY SAND

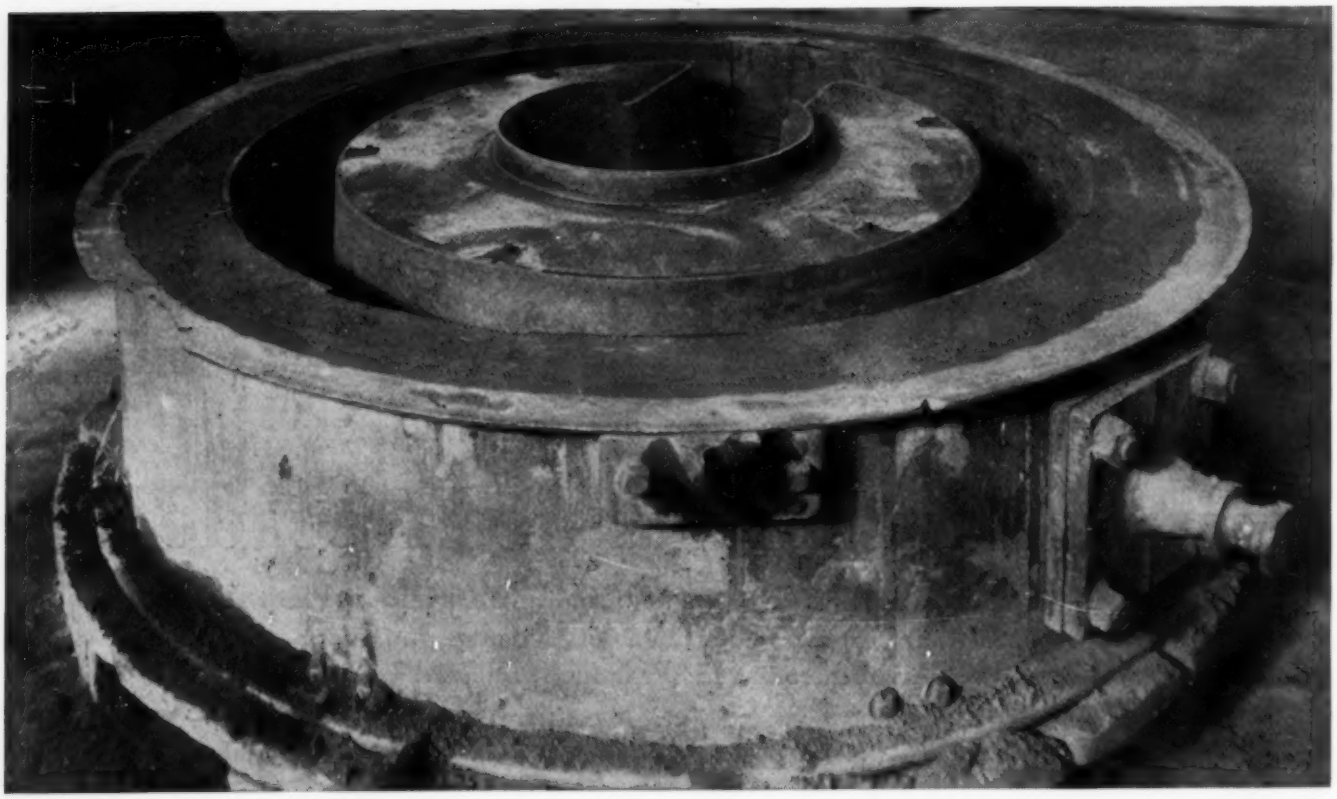

FIG. 2—THE METAL PATTERN SHOWN IN THE MOLD SERVES ALSO AS A CORE BOX FOR THE GREEN SAND PORTION OF THE CORE

which have actually developed. Of course, the present demand for electric ranges was not anticipated in 1900, but a constant growth in the use of cooking stoves throughout the country was wisely foreseen. The present extensions were started before the full significance of the depression of this year was apparent, and the fact that the construc-

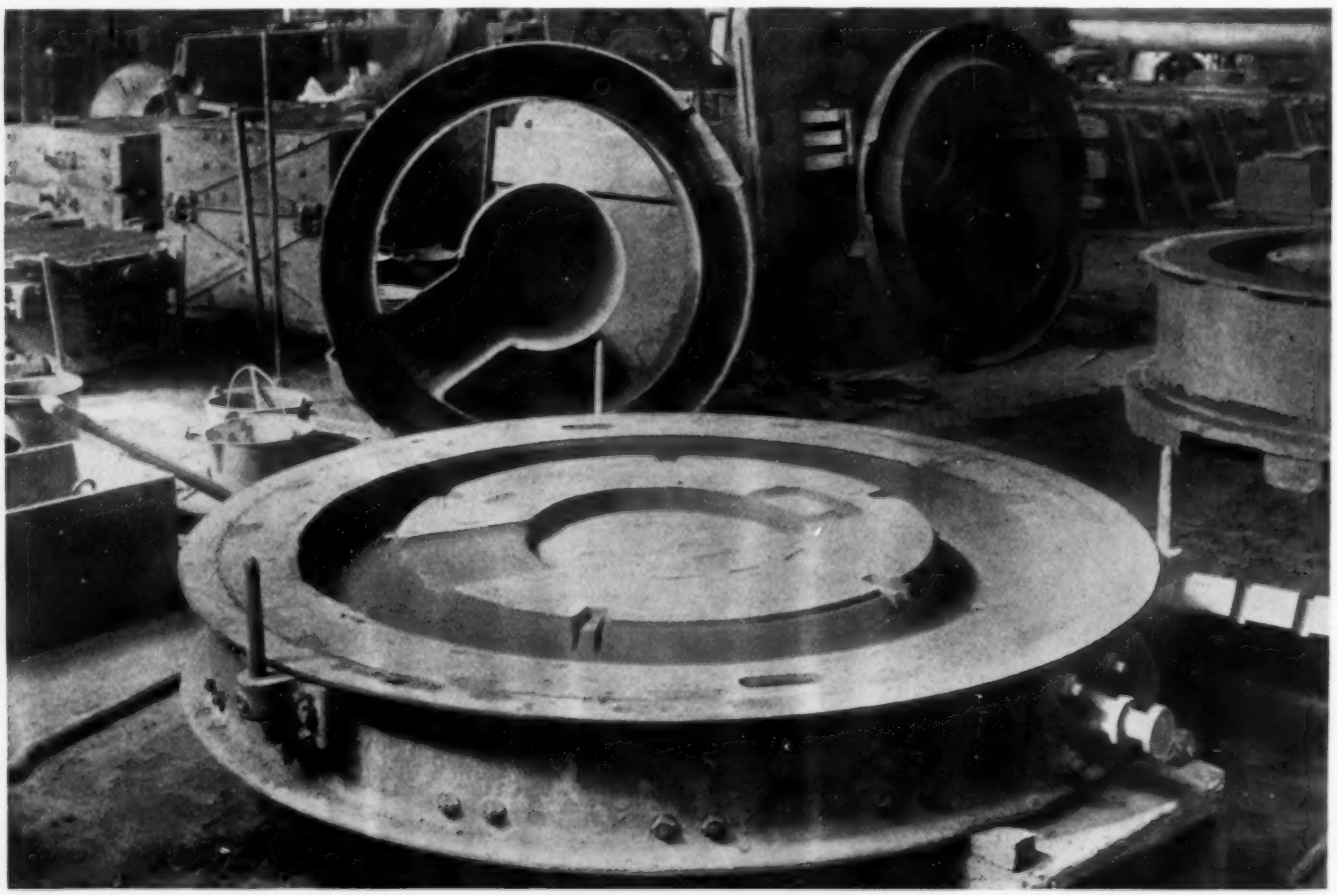

FIG. 3—THE COMPLETED COPE IS SHOWN IN THE FOREGROUND WITH THE TWO PARTS OF THE PATTERN SHOWN IN THE REAR

tion has been carried through to completion as planned, shows an encouraging faith in the stove industry.

The demand for electric and gas ranges was the principal factor in making the additions at this time. However, the company manufactures a wide range of heating appliances, including gas and electric stoves, coal ranges, boilers and furnaces. This varied line gives a range of molding practice in respect to size and design of casting which is seldom found in a manufacturing stove foundry. Most of the small work, such as burners, stove plates, stove legs, etc., is made up on molding machines from mounted patterns. In general, the scheme on the foundry floor is to have the small parts made at one end with a gradual increase in size of castings up to the other end, where the large boiler and furnace castings are made. Transporting material has been carefully worked out throughout the plant so as to keep a steady flow from the raw material bins, through the foundry, cleaning rooms, and finishing shops, to the storage warerooms. Molding practice has been given special attention in the handling system. An extensive overhead trolley system reaches within a short distance of each molder on the floor. The hot metal is carried to the molders which reduces their work, and is said to cut down the percentage of faulty castings. The general molding scheme may be seen from the following through the work in connection with a large furnace dome casting.

FIG. 5—THE COMPLETED MOLD WITH CORE IN PLACE READY TO BE CLOSED FOR POURING

One of the most interesting features in connection with this casting is the unusual core construction which consists of two dry sand rings or cores carrying a section of green sand between as shown in Fig. 1. The top and bottom ring cores are shown in Fig. 4. The central green sand portion is molded in place in the interior of the drag half

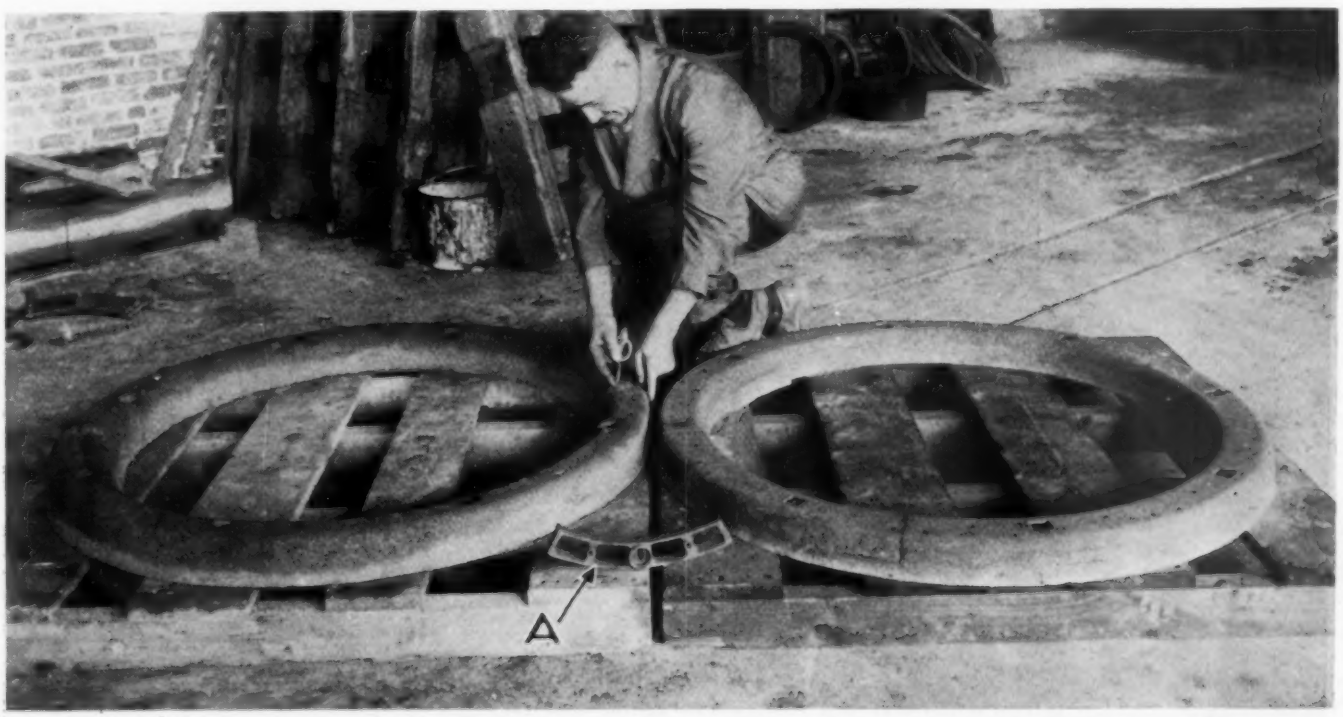

FIG. 4—THE DRY SAND RINGS ARE MADE UP AND BAKED IN THE COREROOM AND THE GREEN SAND CENTER LATER IS MOLDED BETWEEN THE TWO ON THE FOUNDRY FLOOR

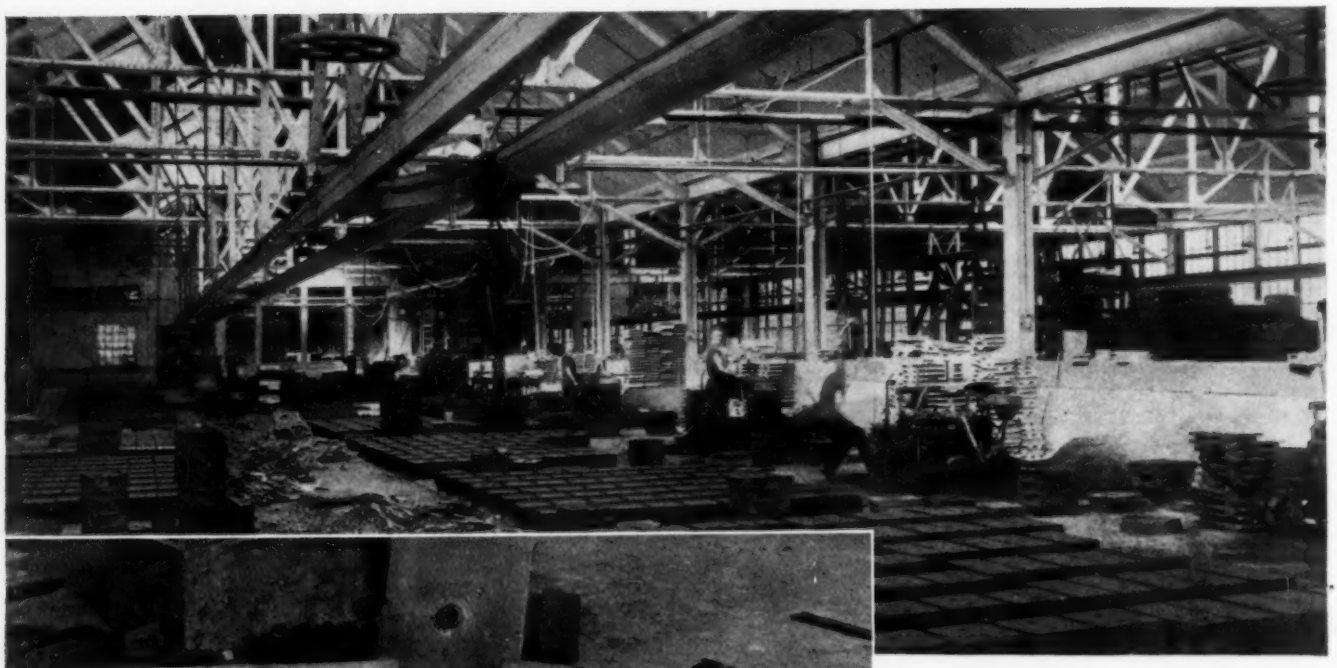

FIG. 6—ABOVE—A PORTION OF THE FOUNDRY WHICH HAS JUST BEEN COMPLETED TO TAKE CARE OF CASTINGS FOR ELECTRIC RANGES FIG. 7—GAS BURNER CASTINGS REQUIRE CORES OF UNUSUAL SHAPE—THE COMPLETE CASTING, THE PATTERN, THE CORE AND CORE BOX ARE SHOWN AT THE LEFT FIG. 8—STOVE LEGS ARE CAST INVERTED SO THAT THE METAL FLOWS UP FROM THE LEGS TO THE CONVEX SURFACE

of a metal pattern which has been especially designed for this purpose. The drag portion of the flask is rammed up in the usual way around the metal pattern. It then is inverted on a bottom board and is shown in this position in Fig. 2. The lower ring of the core is then set in place at the bottom of the interior of the pattern. Arbors are spaced throughout both the top and bottom dry sand rings, to take rods which hold the two in place and which form a support for the entire core when it is being lifted out and replaced. One of the small arbors is shown in the foreground, at *A*, in Fig. 4. After the lower ring has been placed, the inside of the mold is packed with green sand to the point where the upper ring is to come. The upper ring is then set in place and the cope portion of the pattern which is shown at the right background of Fig. 3 is set in place over this core, and the cope of the flask lowered down onto the drag.

After the cope mold has been rammed and lifted off and the cope pattern removed the core is lifted out by means of the spider frame work shown in Fig. 1 After this, the drag part of the pattern is rapped and lifted out and the core carefully set back in place on small chaplets, which hold it away from the mold surface a distance equal to the thickness of the metal pattern, and thus in exactly the same position in relation to the whole mold, as it was in at the time it was made up. The core construction is unusual yet forms a relatively simple and efficient way of molding a core. In effect, it amounts to the main pattern being used on its outer surface for making the mold, and on its inner surface for making the core.

Fig. 3 shows the completed cope with the two parts of the pattern in the background. Fig. 5 shows the core in place and the entire mold completed, with the cope ready to be lowered. It takes one molder one day to make a mold of this type.

The casting itself is composed of relatively thin walls of irregular shape, and considerable care is required throughout in making the mold and pouring the metal. The question of venting is important. A complete net work of vent tubes extends around the green sand portion of the core and connects through the cored neck with openings to the air at the center, as shown at *B* in Fig. 5. The sand used for the dry rings of the core is a medium-grain core sand obtained from local hills and mixed to the desired consistency with flour and water in a core sand mixer.

The core room is located centrally with respect to the foundry floor, adjacent to the cupolas and close to the section where the heavy molding is done so that the large dry sand cores are carried a relatively short distance. The core room contains three core ovens, two at one end, with parallel tracks extending into each, and running the entire length of the room, and one at the other end. Molding benches are arranged along each side of the tracks and the cores ready for baking are placed on small iron trucks. When the trucks are fully loaded, they are pushed into the ovens and the cores are baked. The large core rings which have just been described are baked one and one-half hours at a temperature of 400 degrees. The sand used in the center portion in this core is No. 1 Albany molding sand.

How Sand is Handled

Great care is taken in handling and treating the sand used throughout the entire foundry. Smooth, fine-grain castings such as required in stove work cannot be produced unless the molding sand is fine and uniform. Fine grained Albany sand is used for all the stove and range work. Sand for stove plate work before it is used in the foundry is first submitted to a drying and milling treatment which breaks up any lumps and distributes the bond of the sand carefully throughout the entire mass. The sand treating room is in a separate building, located parallel to the molding shop and back of the cupolas. An overhead trolley system extends through into this sand room from the foundry side and a railway siding passes along the other side of the room. The general travel sequence of the sand from the car to the molders' floors is as follows:

Railroad cars dump directly into large bins which separate the different grades of sand according to fineness. From these bins it is passed to hot water drying tables, and then by specially constructed wheelbarrows to a conveyor which carries it up to the milling machine. After this, it passes through fine mesh revolving screens into the hopper bins where it is ready to be drawn off as desired, when it is carried in trolley conveyors to any point in the foundry. Part of the conveyor system is shown in Fig. 6.

In the molding section of the plant the procedure is much the same as it is in any modern foundry. The molds are shaken out and castings placed in the gangways after the molders leave at night, and the sand is prepared ready for use when the molders arrive in the morning. The sand in this department is all of the same grade, No. 1 Albany sand, and new sand is furnished to mix with the old, as desired by each molder.

The new addition to the foundry is at the small castings end of the molding shop and is shown in Fig. 6. As may be noted, the design of this building conforms to the general type of construction of the rest of the plant. Something of the nature of the small castings may be understood from Fig. 7, which shows what is known as a rear gas burner casting. The mold for this casting is made on a molding machine from plates as shown in the illustration. The core is of unusual shape, being nearly 20 inches long for some stoves and approximately three-quarters of an inch in diameter at the neck. The two halves of the corebox are shown at *C* in the illustration. Between the two portions of the box is shown a vent plate, *D*, which is used to put a ¼-inch hole through the center of the core. The completed core is shown at *E*. After the

(*Concluded on Page* 925)

FIG. 11—NEATNESS IN THE STORAGE OF FLASKS PAYS THROUGH GIVING MUCH GREATER LIFE

Making Water Turbine Castings-II

Method of Molding Small Runners with Vanes of Curved Steel Plate and the Larger Sizes with Cast-Iron Vanes—Molds for Latter Composed Almost Entirely of Dry Sand Cores

THE casting of a turbine, inside the scroll case, known as the guide ring, is of radically different shape from the casing. As may be judged from the casting illustrated in Fig. 2 the speed ring readily lends itself to molding with cores. The number of bolt holes threaded into the flanges indicates how essential it is to have solid homogeneous iron in the casting. Great strength also is required to withstand the enormous pressure of the water rushing through the gates to the wheel inside.

Large and Small Wheels

The runner, examples of which are shown in Fig. 1 is an interesting casting. As has been noted, it consists of a band which may be seen around the vanes in the front, a hub at the back and the vanes themselves, which may be either cast iron or pressed steel. The extremes in sizes of the wheels which vary from more than 10 feet to less than 1 foot in diameter, is illustrated in Fig. 1. Size and the kind of vanes govern the method of molding. The smaller wheels which are not molded in pits are handled differently from those which are molded in pits.

The first step toward making a casting to be molded with steel vanes in a flask is to set the vanes accurately. This is done as illustrated in the insert page 921. The vanes are received in the foundry pressed into shape by the use of a cast-iron former and with prick punches at the center of the head. A gang of mechanics trained to this special work then sets the vanes on a wood base. A cast-iron center serves definitely to locate the inside lower edge of the vane. Each vane is attached to a lug in the central casting with a hook inserted into one of the holes placed in the edge of the vane. These holes provide a passage for the metal cast around the vanes to unite firmly and prevent the vane from becoming loose as the two do not completely fuse together. The outside edge of the vane is located by a groove in a wood circle on the base. The correct angle at which the vane should stand is determined by a templet with a pointer shown at *P* in insert Figs. 3 and 4, which must be exactly over the prick punch on the vane. When the correct stand for the vanes is determined a wood prop is placed behind the vane to hold it in position. A wood block, *A*, Fig. 3, is placed between each pair of vanes to fix this distance. Every vane is then marked in determined intervals from a definite point. The interval varies from 2 to 4 inches depending on the size of the wheel. The intervals are numbered consecutively and the distance between each two vanes at each numbered interval is measured accurately and reported to the engineering department. After all the vanes are in position, a more permanent method of holding them is adopted by attaching each vane to a steel ring with hooks clamped to the vanes by screw *C* clamps. A set of vanes ready to be attached to the ring is shown in Fig. 3. The hooks placed on the vanes in readiness for the workman who is to attach the vanes may be seen at the top. This man sets the first hook at approximately the right place then attaches two others equally spaced around the circle. When these three hooks are exactly located, it is an easy matter to adjust the remainder of the hooks. With all vanes hooked to the central ring the vanes are held securely in place and the props are removed.

Hand Rammer Used in Center

The vanes now are ready for molding and the board is picked up by the crane and carried to the molding floor where a flask is placed around it and filled with sand, ramming being

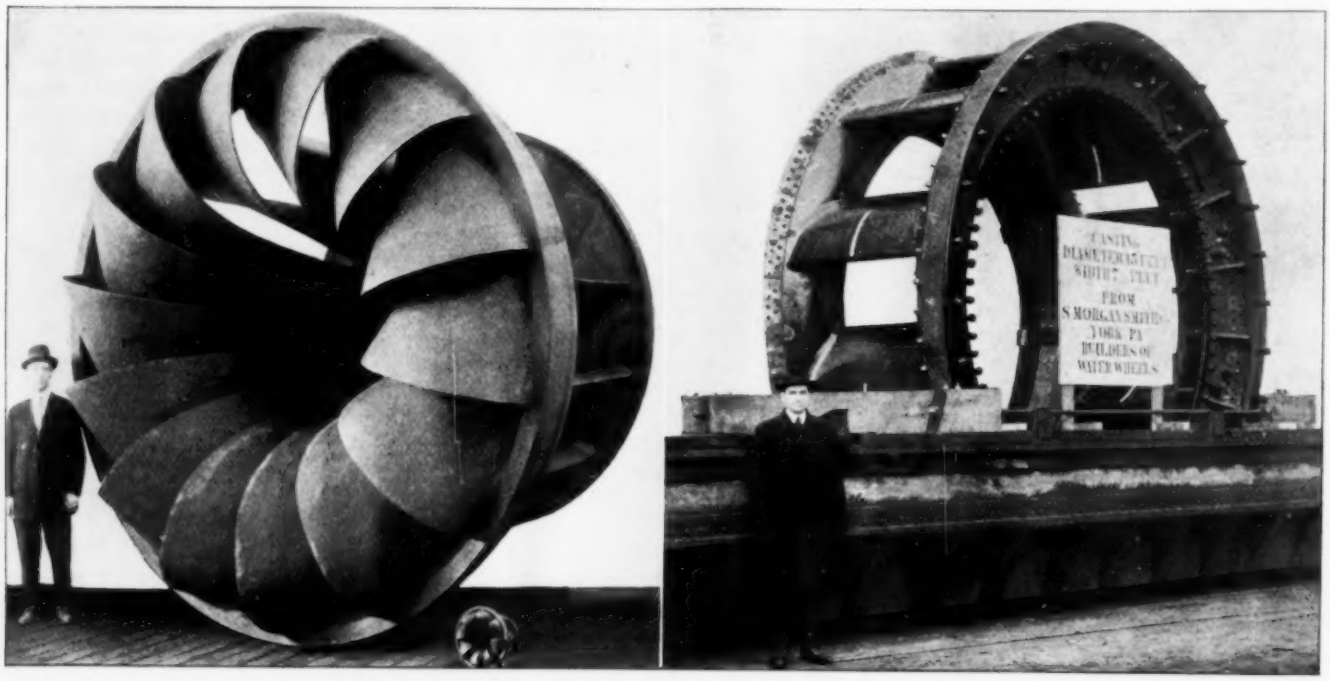

FIG 1—WATER WHEELS VARY GREATLY IN SIZE—THE VANES ON SOME ARE STEEL WHILE OTHER BLADES ARE CAST IRON—FIG. 2—THE SPEED RING WITH ITS VANES IS CAST IN A MOLD MADE ALMOST ENTIRELY FROM CORES

FIG. 3—AFTER THE VANES ARE CORRECTLY LOCATED THEY ARE CLAMPED TO A RING WHICH HOLDS THEM IN POSITION

FIG. 4—THE VANES ARE PACKED WITH SAND IN A FLASK BEFORE THE RING AND WOOD BLOCKS HOLDING THEM IN PLACE ARE REMOVED—THE INSERT ILLUSTRATES HOW THE VANES ARE SET WITH A TEMPLET

FIG. 5—WHEN THE MOLD IS RAMMED IT IS TURNED OVER, THE FLASK REMOVED AND THE SAND SWEPT TO THE BASE OF THE VANES

FIG. 6—CORES FORM THE BAND ON THE WHEEL—NOTE THE TWO HOLES FOR THE DOWN GATES

FIG. 7—WHEELS OF DIFFERENT HEIGHTS ARE MADE IN THE SAME FLASKS—A BAND OF THE REQUIRED HEIGHT IS INSERTED TO MAKE THE NECESSARY ADJUSTMENT

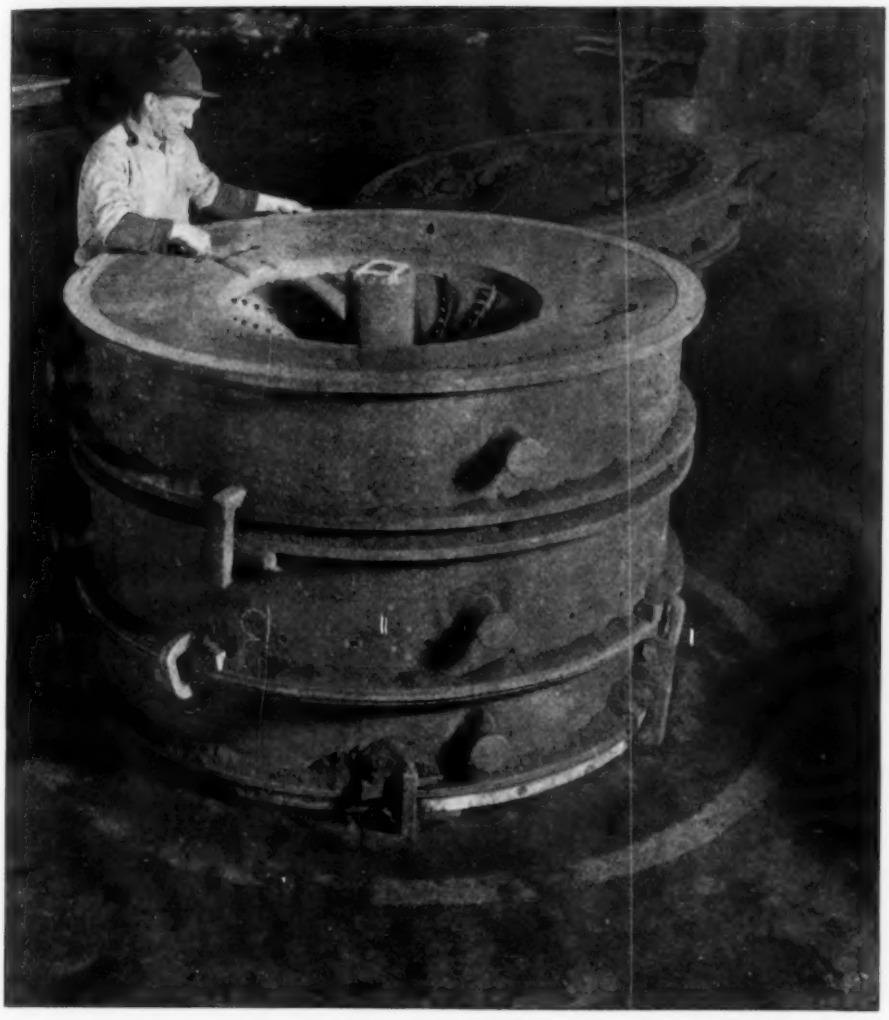

FIG. 8—SUBSEQUENT TO RAMMING THE COPE THE HUB PATTERN IS WITHDRAWN LEAVING PARTS OF THE VANES EXPOSED TO BE SURROUNDED BY THE CAST IRON ENTERING THE MOLD

done with a pneumatic rammer, Fig. 4. However, the center is rammed with a hand rammer to avoid danger of striking the blades and knocking them out of place.

One flask is put on after another until the entire mold is rammed. The clamping ring is detached when the molding sand is rammed sufficiently high to hold the blades securely. A bottom board is attached to the top of the mold with clamps and the whole is rolled over. After the mold is rolled over the flasks with the exception of last one are removed with the crane. The sand is cut away and a sweep is set upon the base pattern as illustrated at *A*, Fig. 5. This illustration is a composite to show different steps taken in producing the mold. In sweeping the mold, a space is left at the bottom and a wood ring pattern made in sections is set in. This allows the sand to be rammed on the inside of the ring to form a corner with a firm surface against which the metal can flow.

The sweep cannot cut the sand between the vanes so this is cut away by the molder and after being slicked is coated with blacking. At the left in Fig. 5, the mold is shown as it appears after the side has been swept and the ring pattern placed. The rough sand may be noticed between the vanes, the ring pattern drawn, and the surface slicked and blackened. The surface between the vanes is reinforced with short nails having large heads, known as 2¼-inch or 11-penny foundry nails. Small circle cores are inserted in the ring formed by the pattern and the band is formed by cores such as the molder has in his hand. Of course in making the mold a similar situation to that shown in Fig. 5, which has been set for illustration would not be found, for the sweep is taken off as soon as the mold is swept and the sand between all the vanes is cut away and blackened before any cores are set. Also the vanes are washed with a dilute solution of water glass carrying a pigment of red lead.

Sweep Forms Groove

Fig. 6 also shows a view of the sweep as it would appear in sweeping the mold. Here may be seen the shape of the sweep at the bottom which forms the groove for the ring cores. After the cores are all set, the flasks are replaced one at a time and rammed full of sand. A parting is made on top, the flask flange serving as a guide on the outside and hub pattern acting as a guide on the inside. This illustration also shows the

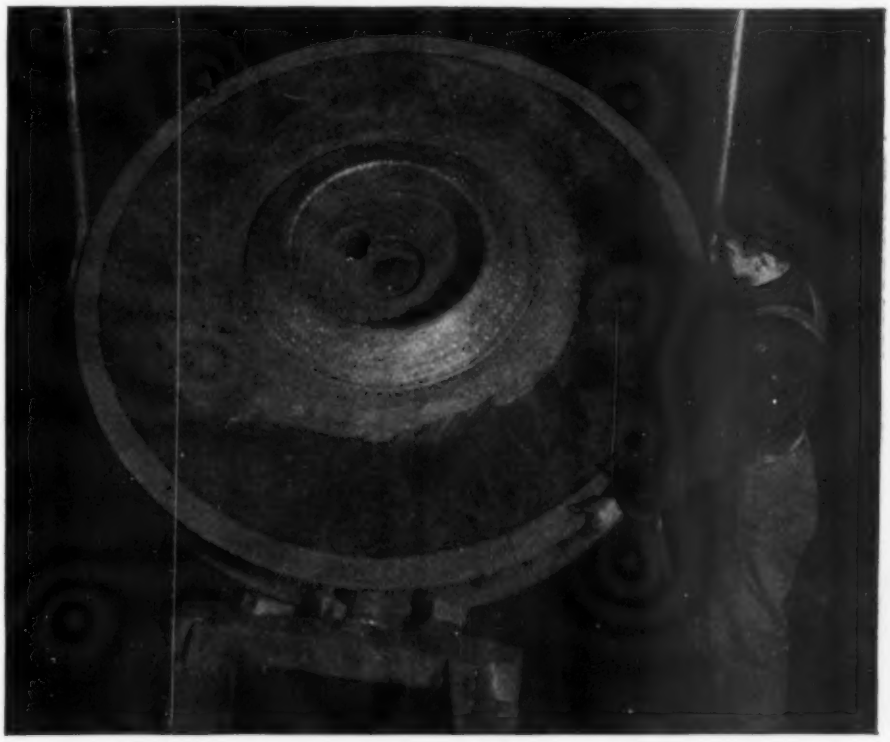

FIG. 9—IN THE COPE THE HUB SECTION OF THE MOLD IS NAILED AND BLACKENED—NOTE THE HOLE FOR THE RISER IN THE CENTER

two gates on one side of the mold. One of the pins used to form the down gates is shown in the foreground. Two similar gates are located on the other side of the mold. One of the molds, with the hub pattern withdrawn and the hub core set, is shown in Fig. 8. Here also it was necessary to cut away the sand between the blades to expose enough of the blade to the molten metal to anchor the blade in the casting. In both the hub and the band it may be noticed that holes are left in the extremities of the blades to allow the cast iron to flow in and secure the blade firmly. The molder, Fig. 8, is shown finishing the gate. Two of these are provided on each side of the mold. The metal comes down a single gate on each side of the cope and strikes the sand in the cheek then it parts in two ways. Each leads to the down gate to the band and also to a runner in the cheek which leads to the hub. The cope, molded from a pattern of the hub is shown in Fig. 9. The print for the hub core may be noted in the center and beside it is shown the hole for a small riser. On both sides the two pouring gates are indicated.

Many of these runners are made which vary slightly in height and to overcome the necessity of having different flasks for each size runner, bands are kept in stock to inset between the flasks. These bands vary from 2 to 8 inches in height in steps of ¾ inch. A band in position is shown at *A*, Fig. 7. This also illustrates another of the bands held by a molder. Wood blocks, indicated at *B*, *B*, are wedged between the flasks on top and underneath the band to prevent the latter from springing and giving the mold an uneven set.

FIG. 11—THE LARGER WHEELS ARE MOLDED IN PITS AND THE MOLDS ARE NOT TURNED AS WITH THE SMALLER WHEELS

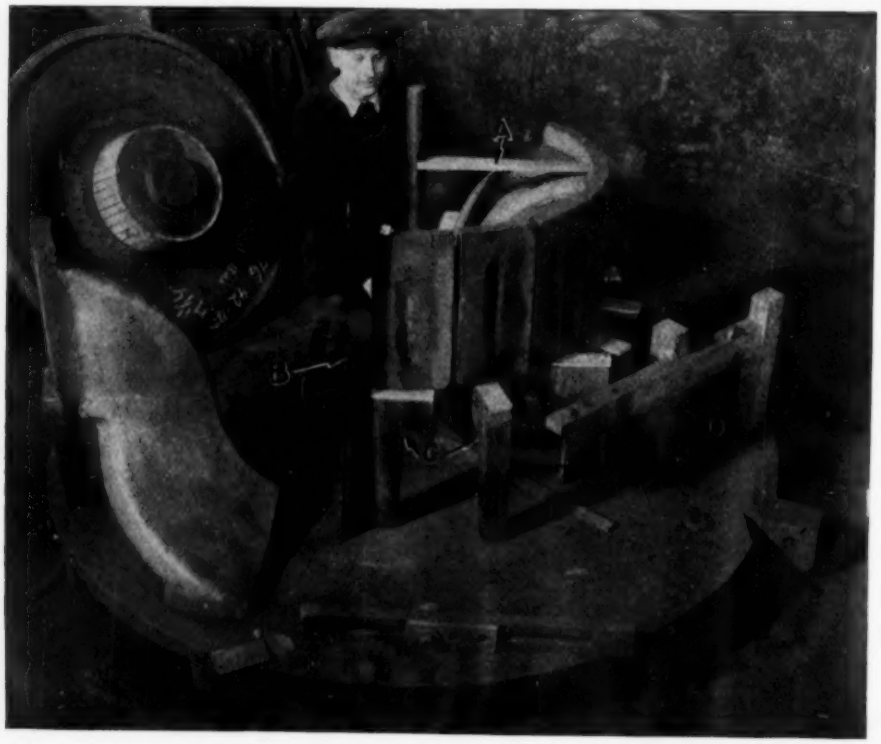

FIG. 10—WHEELS WITH CAST-IRON VANES ARE MOLDED WITH CORES—THE BASE PLATE IS PARTED IN HALVES SO THAT THEY CAN BE SEPARATED TO SET THE LAST CORE

Molding Method Changed

Larger wheels with steel vanes are molded in a different manner from the smaller ones. In the first place, the larger wheels are molded in pits and the molds are not turned over as in the case of the smaller ones. Fig. 11 shows the vanes for a large wheel prepared for the sand. The vanes are held in place at the top by a ring bolted to cross arms held by a spindle screwed into a bottom plate. Each vane is bolted to the ring through a hole in the edge as indicated at *A*, Fig. 11. The other end of the vane is bolted to a ring, *B*, on the bottom plate and also to lugs on this plate as illustrated at *C*. Sand is rammed two feet above the band and swept for the inside of the band after which the band cores are set.

Then sand is rammed around them and completely to the top of the mold. Space is swept between the vanes at the top and finished as has been described for the first wheel. A cope is fitted in the same manner as described. A different method of pouring is used as it is desired not to pour the hub until an hour after the band has been poured. The advantage in this is that it prevents danger from gas explosions, also the band contracts and takes its set before the hub is in position to strain the vanes by its contraction. Before the hub is poured a spark is dropped into the mold and causes a slight explosion of the collected gases.

Molds for wheels in which the vanes are cast iron, are made almost entirely of cores. Fig. 10 illustrates the start of such a mold and shows Charles W. Schaberg, foundry foreman, who has charge of all molding and melting. The bottom plate consists of two halves of a circle. A spindle is set in the center and cores are assembled around it as illustrated. The distance from the center is determined by the sweep *A* and the cores are straightened with the square *B*. The cores are held in position temporarily by props and wedged as indicated at *C*. After all but one of these cores are in place, the props are taken away, one at a time, and the band cores are put in place. To set the last center core, the two halves of the center plate are separated. As these are arranged on rollers this is done easily. An arm, bolted to the brace *D*, supports the one central core whose base is on one side of the bottom plate but its top extends over the other half and it must be supported from the same half on which it rests. The band cores are then set one at a time removing the support immediately preparatory to setting each band core section. A flask is then placed around the cores and rammed with sand to the top and finished similarly to the wheel previously described. The pattern for the cope is shown to the left, Fig. 10.

Heavy Work in Main Bay

The greater part of the orders coming to the foundry are for heavy castings. The foundry, 640 feet long by 75 feet wide, is divided into a main bay 50 feet wide and a side bay 25 feet wide. The main bay is practically devoted to all heavy work requiring the services of a crane. Three traveling cranes serve this bay. The smallest has a capacity of 10 tons, the next 20 tons and the largest 30 tons. With two cranes acting together loads over 50 tons can be handled, but the molding is usually so arranged that no molds above this weight need be lifted.

On the side of the foundry opposite to the side bay are three cupolas lined to 39 inches, 54 inches and 66 inches inside diameter, respectively. The two larger cupolas are used for melting iron and both are put in blast the same day when needed for an extra large supply of metal. The smaller cupola is employed for melting copper alloys for castings too large for the melting capacity of the crucible furnaces, a battery of pit furnaces being located in one corner of the foundry. To melt the brass, the cupola is started as it would be for melting iron. When the fire is burned through the coke bed, charging is begun at once and the blast is turned on. This is not as strong as that used for iron as only 4 ounces pressure is applied. The tap hole is not closed, but the metal is allowed to run in the ladle as melted. The alloy; copper, 88 per cent; tin, 10 per cent; and zinc, 2 per cent, and the bearing metal; copper 85 per cent; tin, 5 per cent; lead, 5 per cent, and zinc, 5 per cent are the most frequently made. All the metal is not put into the cupola, only the copper and scrap being so treated. The scrap never is allowed to exceed 25 per cent of the mixture. The three metals with the lower melting points are melted in the crucibles and added to the metal from the cupola in the ladle. A large percentage of all the metals in the scrap, except copper are lost, but good castings are secured and the company feels it is more profitable to have a little larger melting loss than to install crucibles for melting such large charges. Some of the castings weigh 13,000 pounds which would require an unduly large crucible capacity.

Build Addition Planned Decade Ago

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core has been formed, it is left resting in one half of the core box, and then placed in the core oven and baked. One molder working exclusively on this casting using a plate as shown turns out 18 to 20 molds in an hour.

The tendency throughout the foundry is to reduce as many operations as possible to plate work. Fig. 9 shows a method of molding stove legs. The flask shown on the machine contains a mold for but one leg. However, a plate showing a leg of another type which will give two legs to each mold has been constructed and is shown at the left. These leg molds are made inverted. That is, they are so placed that in pouring, the metal will run up to the curved outer surface rather than down which is the more usual practice. This method of pouring may be seen from the lower plate at the left where the knife edge gates are shown connected to the lower edges of the legs. The casting shown has the old type of gating.

The general arrangement of the buildings of the plant has not been disturbed by the two recent additions and the sequence of operations will continue to be the same. Small tractors are used to carry parts to and from the new sheet metal working department. Considered as a whole, the plant is seen to be of unusual arrangement and attractiveness.

The management believes strongly in neatness and the plant's surroundings are almost park-like, with their green lawns and shrubbery. An unusual example of neatness is shown in Fig. 9, which is a corner of the yard photographed unexpectedly just as it was found. This is the corner devoted to storage of flasks which so often form a temptation to disorder and lack of neatness in a plant. The superintendent says that this neatness pays many times over in the increased life of the flasks themselves.

Equipment Company Has Moved to Buffalo

The Powdered Coal Engineering & Equipment Co. moved its offices and manufacturing plant from Chicago to Buffalo, New York on Nov. 1. The personnel of the organization has been somewhat changed. H. B. Pruden has been elected as chairman of the board and J. W. Lansing of Buffalo has been elected president. The new board of directors of the company is as follows: J. W. Lansing, Fenton M. Parke, J. E. Finley, Harry R. Wait, J. C. Trefts, H. B. Pruden, B. W. Wistar, W. M. Faber and Stephen T. Lockwood.

Open New Foundry

The new foundry of Gilbert & Barker Mfg. Co., manufacturers of valves and fittings at West Springfield, Mass., was formally opened, when Robert H. McNall, president of the company, poured metal into molds on Nov. 1. The new building is 80 x 400 feet, and is one of the largest and best equipped in New England. The capacity of the furnace is approximately 100 tons per day.

Orton & Steinbrenner Co., 608 S. Dearborn street, Chicago, manufacturer of material handling machinery, has opened an office at 528 Detroit Savings Bank building, Detroit. Ben L. Whitney is in charge.

Problems Involved in Casting Metal

With Good Foundry Practice Sound Castings Can Be Obtained from Any Metal Provided There Are No Reactions Which Lead to The Formation and Evolution of Gas

BY THOMAS TURNER

SMALL traces of impurity may exert a profound influence on metal which has to be subsequently worked. It usually is admitted that good foundry practice is much more important than slight variations in chemical composition or physical properties. Speaking generally, with good foundry practice, sound castings can be obtained from any metal or mixtures of metals, provided there are no reactions which lead to the formation and evolution of gases, and that there is no excessive tendency to segregations during solidification.

Pure substances, such as metals, generally melt at a definite temperature, and pass sharply from the solid to the liquid state. Mixtures, on the other hand, may melt over a range of temperature and pass through a semi-fluid stage, during which the viscosity may be considerable. As the viscosities are in all cases only a small multiple of that of water, it follows that for practical purposes there is no very great difference between the rates of flow of equal weights of water and fluid metal.

There is one important property of the metals as a class that is so general as to be accepted without comment, and yet upon this property successful casting is dependent. If into a prepared sand mold water were poured, the sand would be wetted and the mold spoiled.

Surface Tension

However, when molten metal is poured into a cavity in sand, the sand is not wetted; and when the metal has solidified any adhering sand readily can be detached. Why a particular liquid wets a solid, while other liquids do not, is at present not fully explained. The difference is due to the operation of molecular forces whose effects are seen in cohesion and in surface tension of the liquid. The properties of the solid have also to be considered. The surface tension of metals has been dealt with historically, theoretically, and experimentally by S. W. Smith, who shows that the influence of temperature upon the surface tension of ten common metals in the liquid state are as follows:

	Dynes per centimeter
Antimony	274
Bismuth	346
Lead	424
Mercury	447
Tin	480
	Dynes per centimeter
Aluminum	520
Zinc	707
Silver	858
Gold	1018
Copper	1178

Source of Trouble

From the internal pressures of solid iron and nickel it is probable that the surface tension of these metals in the liquid state is in the neighborhood of 1200. The hardness, cohesion, and surface tension of a metal are functions of the atomic volume. It is to the two latter properties, cohesion and surface tension, that we owe the fact that fluid metal does not wet the mold. Since metals, at casting temperatures, are far removed from their boiling points their surface tension is slightly altered by ordinary variations of temperature.

A special surface effect noted with some metals, is a source of trouble in casting. If the metal oxidizes and forms an infusible oxide, a skin is produced which may be sufficiently strong to prevent the flow of the metal into the sharp angles or thinner parts of the mold. This is particularly apparent when casting aluminum and aluminum alloys; and it is one of the causes which has prevented any extensive use of aluminum as a softener in iron-founding.

Attention may be called to a simple method of obtaining an approximate determination of the surface tension of a metal, at a temperature near its freezing point. The metal or alloy to be tested is melted and poured out on a flat slab, to obtain a plate of approximately circular shape. The thickness of the plate increases with the surface tension of the metal in accordance with the following equation:

$$T = gd\frac{h^2}{4},$$

where T is the surface tension in dynes per centimeter, g is 981 (the gravitational acceleration in centimeters ÷ sec.^{2}), d the density of the metal, and h the thickness of the plate. It is assumed that the metal does not wet the slab; otherwise it is necessary to introduce a correction in the value of h.

Allowance could be introduced for contraction during cooling, and the slab could be heated to the melting point of the metal to be tested to ensure greater accuracy, if desired. A. Ferguson classifies the methods for measuring surface tension, under twenty different heads, and to these may be added the approximate method described.

It is remarkable how many problems in metallurgy the property of surface tension enters. Thus it is not only important in connection with casting operations, but it plays a part in determining the melting point of small crystalline granules, and in producing the hardness caused by the cold-working of metals. Its influence also is very great in the flotation processes for the separation of metallic minerals.

Latent Heat of Fusion

Provided that other conditions are kept constant, the time required for the solidification of a metal will vary with the latent heat of fusion, or the heat absorbed in passing from the solid to the liquid state. In the following list it will be observed that there is a striking difference between the latent heat of aluminum and that of other fusible metals. The values given are from determinations by F. Wüst.

	In Calories per Gram
Lead	5.47
Bismuth	10.23
Cadmium	10.81
Tin	13.79
Gold	15.87
Zinc	23.01
Silver	26.02
Manganese	36.05
Antimony	38.86
Copper	40.79
Iron	49.35
Cobalt	58.23
Nickel	56.08
Aluminum	93.96

The coefficient of thermal expansion of the metals, as a class, is greater

Abstracted from a lecture delivered by Prof. Thomas Turner, M. Sc., A. R. S. M. before a meeting of the Institute of Metals at the House of the Institution of Mechanical Engineers, Storey's Gate, Westminster, London.

than that of non-metals. The metals, however, vary considerably among themselves, the coefficient of low-melting-point metals usually being greater than that of those which are less fusible. Hence glass and platinum have very nearly the same coefficient, and the applications of this fact are familiar to the chemist or physicist. Certain metals, whose metallic properties are less pronounced, like antimony or arsenic, have a low coefficient, and also a relatively low melting point. For the purposes of casting, aluminum and antimony afford an interesting contrast.

The obtaining of good castings in aluminum thus depends on the recognition of three factors:

1. The high contraction of the metal on cooling.
2. The stage of plasticity between the liquid and the solid state.
3. Low tenacity at high temperatures.

With pure metals the rate of contraction from the hot liquid to the cold solid usually is regular, though not strictly linear, and there is a sharp contraction at the moment of solidification.

Contraction and Shrinkage

Alloys usually contract less than the mean contraction of their constituents; eutectics usually show a low contraction; while the net alternation in length of a casting, as compared with the size of the mold, depends, *inter alia*, upon the thickness of the metal. The term "shrinkage" was applied by the late W. J. Keep to the difference between the length of a cold casting and the length of the mold into which it was poured. But a more complete consideration of the subject involves two separate stages, namely, the contraction of the liquid metal on cooling to the point of solidification, and the subsequent contraction or shrinkage in the solid, or partially solid, material. These effects may be conveniently studied under two separate heads, namely, pure metals, and alloys or mixtures.

Starting with a pure metal in the liquid state, as it cools it contracts regularly until it begins to solidify. There is a well known exception in the case of bismuth, which behaves like water, in that the liquid has a point of maximum density, after which it regularly expands, and sharply again on becoming solid, after which it regularly contracts. Cast iron, which is a mixture, also expands when cast. But it differs from a pure material, such as bismuth or water, in that the greater part of the expansion occurs after the metal has begun to solidify.

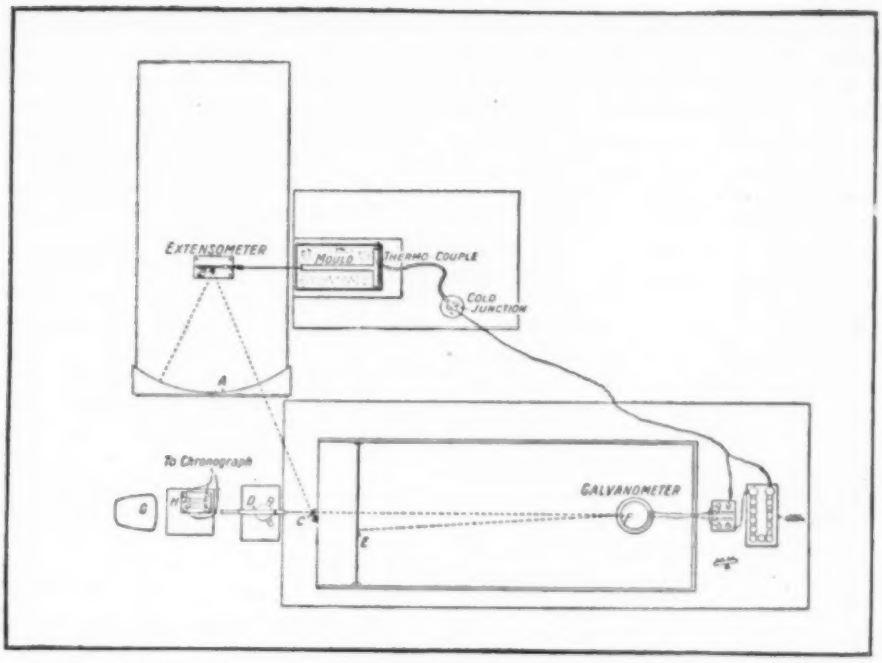


FIG. 2—PLAN OF MOLD, MIRROR EXTENSOMETER AND PYROMETER

Cause of Piping

There is a temperature gradient during cooling, as a result of which crystallization begins at the outside, and is completed near, but somewhat above, the centre of the mass. Metals poured from a low temperature, and those with a high coefficient of expansion, will *pipe* more in the ingot. The piping is due to a shortage of fluid metal just before, or at the moment when solidification is completed. If there is any construction between a mass of metal in the casting and the *gate*, the metal will solidify in the thinner portion before the thicker part has become solid. Liquid contraction will then go on in the thick part, and as no liquid is available to fill up the intercrystalline spaces, sponginess results. Such sponginess, or *draw*, may be regarded merely as a pipe in the wrong place. Ill-formed and irregular in shape it may be, but it is a variety of piping.

The remedy is well known to the practical man; the metal must cool from the outside regularly to the gate,, and behind every crystal as it forms there must be fluid metal in communication with the gate, so that there be no interruption in the feeding in of more liquid to fill the spaces resulting from fluid contraction.

Perhaps the best-known device to ensure *dense metal* is the provision of a casting head of sufficient height and thickness. Let it be assumed for ex-

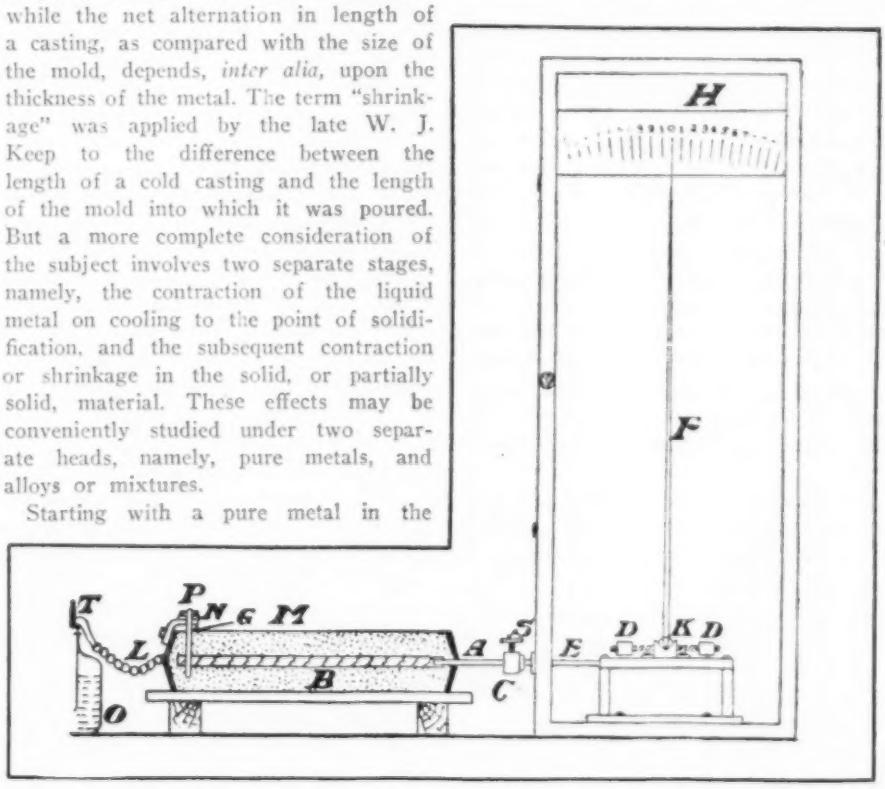


FIG. 1—EXTENSOMETER AND MOLD IN POSITION AFTER POURING, *M*, SAND MOLD IN SECTION, *B*, CAST BAR, *A*, CONNECTING BAR WHICH PROJECTS INTO THE METAL, *P*, PIN HELD IN PLACE BY NUT AND BOLT *N*, *O*, COLD JUNCTION, *T*, THERMOMETER, *L*, THERMOCOUPLE LEADS, *G*, GATE BEHIND PIN *P*, *C*, CONNECTING COLLAR, *S*, STEEL SCREW, *E*, CONNECTING BAR, *F*, POINTER, *K*, KNIFE EDGES, *DD*, BALANCING WEIGHTS, *H*, SCALE

ample, that the height of the head of metal is 2 feet. Now a height of 2 feet of water will give a pressure of about 1 pound per square inch. 2 feet of fluid aluminum alloy would therefore give a pressure of about 3 pounds to the square inch and 2 feet of brass or iron about 7 pounds. Now, suppose a large casting has a surface of 5 feet square in a horizontal plane. This would give 60 x 60=3600 square inches and with fluid brass or cast iron the hydrostatic upward pressure would amount to something like 25,000 pounds. Unless the upper box were well weighted it would be spoiled. Such facts are the probable cause for the idea that a good casting head exerts considerable pressure upon the metal, and thus leads to increased density. It is true that metals, like gases, may be made more dense by pressure. The compressibility of solids, including certain metals and alloys, has been experimentally studied by Adams, Williamson, and Johnston, who obtained results of considerable scientific value when using pressure up to about 12,000 atmospheres, or nearly 90 tons per square inch. But the effect of a pressure of 7 pounds to the square inch upon a bar of metal would result in so small an alteration of length as to be quite negligible; and some other explanation must be sought than that of any increased density of the metal itself. The good effect observed is due to two principal causes. Firstly, the hot metal in the head is in fluid contact with the whole of the interior of the casting during the process of solidification, and thus supplies metal to fill up the spaces due to fluid contraction. Secondly, just as a very moderate pressure inside a soda-water bottle is sufficient to prevent the escape of the gas in the form of bubbles so the relatively small pressure of the fluid head metal prevents the escape of gas in the form of blowholes. Blowholes are not formed in the solid, but in solidifying metals. The net result of pressure, therefore, is that while the density of the actual metal remains the same, the density of the casting may be considerably increased, owing to the absence of intercrystalline and other spaces.

Casting Temperature

There is a range of temperature within which the most satisfactory results are obtained when casting any particular metal or alloy. It is only in recent years that quantitative values have been given to these temperatures. Dealing for the present with pure metals only, silver affords a familiar example of the effect of high temperatures in pouring, as the metal is less sound, and does not roll properly if too hot when casting. A simple illustration in connection with lead came under my observation during the war. It was required to cast a small slab of lead on to one end of a long thin strip of brass. The articles were wanted urgently in large quantities, but the rejections were considerable on account of blowholes and other faults in the cast lead. The work was done by a number of girls in a large shop, and the metal was poured into small iron molds into which the ends of the brass strips previouly had been placed. It was not practicable to have a large central supply of fused lead, and each girl had a separate melting-pot and gas burner on her bench. I at once noticed the great difference in temperature which the melting-pots indicated. I therefore asked one girl who had a pot full of lead at a just visible red heat, or say 500 Cent. to turn off her gas-burner and to continue her work until the metal in the pot was too cold to pour.

Problem Is Solved

The strips as finished were all laid out in order, side by side, and perhaps 200 were so arranged, each one having had its lead cast at a slightly lower temperature than the preceding strip. It was at once evident that the bad castings occurred at each end of the series, and that in the middle almost every little block of lead was perfect. To cure the trouble it was evidently necessary to regulate the temperature, but pyrometers were out of the question on account of the number of small pots and the frequent emptying and filling with lead. I fell back, therefore, on the old method of a test by stirring the lead with a strip of soft white wood. This instantly bursts into flame when the lead is too hot, while it requires an appreciable number of seconds to ignite at the proper temperatures, and it will scarcely ignite at all in just molten lead. By this simple means the forewoman in charge was able to instruct the girls, or to test the metal herself, and the trouble was almost entirely overcome.

A. McWilliam and P. Longmuir have shown that better results are obtained, when casting either zinc or aluminum, if an intermediate temperature is employed, than when higher or lower heat is used. The value which gave the best result in their experiments for zinc was about 528 degrees Cent. and for aluminium 691 degrees Cent.

An illustration of the effect of improper casting temperature could also be taken from the casting of chilled cast-iron rolls. If the heat of pouring is insufficient a number of small blowholes or pin-holes appear in the upper part of the roll. In such cases it always is safer to use a high temperature, though excessive heat is to be avoided.

In dealing with casting temperatures it is usual to refer to the temperature of the metal in the ladle, and not to that in the mold. Obviously the latter is the important factor, but the former is the more easy to ascertain or to modify. In practice it is usual to employ bare base metal thermocouples and direct reading galvanometers, to determine the temperature of the metal before pouring. Some excess heat must be supplied, above that required to just melt the metal, if it is to flow in a stream from the ladle and run to the most distant part of the mold. It is not possible to fix a definite amount of superheat, such as 100 degrees Cent. and apply it in all cases. Metals with a high melting point obviously will lose heat more quickly when being poured than those which are more fusible. The weight of metal, its specific heat, the rate of pouring, and the size of casting, all have to be taken into account. A rough approximation may be made by taking a percentage of the difference between the ordinary temperature and the melting point of the metal, and adding this percentage to obtain a suitable ladle temperature.

In taking the density of a series of alloys of aluminum and zinc, I have endeavoured to obtain comparative results by casting each alloy at 5 per cent above the liquidus. In practice a higher superheat is found necessary in some cases, owing to pouring and molding conditions, as much as 20 per cent superheat will not be too much. When dealing with pure metal all that is necessary is that the mold shall be filled with metal at such a temperature, and supplied at such a rate and in such a manner that any entrapped air bubbles, or gas from the mold, may escape before the mass solidifies. Any excess temperature, above that which is necessary to ensure the desired result, not merely leads to waste of heat but may also give inferior mechanical properties in the castings.

Gases In Metals

The fact that castings so frequently contain hollow cavities, or *blowholes*, naturally has led to considerable attention being paid to the relationships which exist between gases in metal under widely varying conditions. Molten steel, for example, may retain many times its own volume of gas chiefly hydrogen and carbon monoxide, and may give off a considerable proportion of these while cooling from the pouring temperature. The nonferrous metals as a class do not dissolve such large volumes of gas, and behave in more varied ways towards gases with change of temperature.

The gas may result from reactions which occur within the metal while it is in process of solidification, or

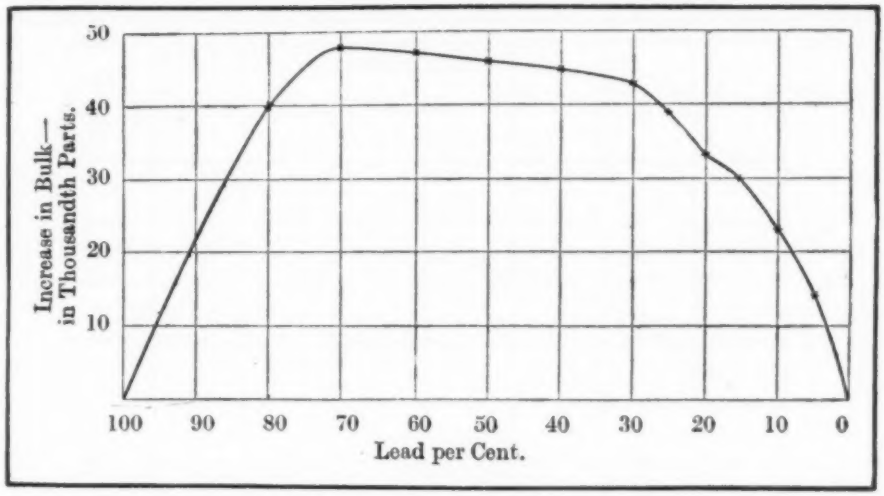


FIG. 3—DENSITY OF TIN-LEAD ALLOYS (FROM M. COQUEBERT'S EXPERIMENTS)

after it has solidified. By a reaction, for example, between oxide and sulphide of copper, sulphur dioxide may be evolved, and it is impossible to cast a sound ingot of copper from a sample of metal in which this reaction is in process. In the same way steel is rendered unsound by reactions between carbon and oxide of iron present together in the fluid bath. Another example of deterioration by gas reaction is that of the effect produced by hydrogen upon copper containing cuprous oxide, whereby the pitch of the metal is destroyed and brittleness results. The unsoundness of castings made from scrap metal largely is due to gas produced by reaction; though trouble also arises from oxide and from infusible combinations. From the metal caster's point of view gas of reaction presents the greatest difficulty, and the only remedies are (1) to complete the reaction, either by sufficiently long melting and stirring, or by the addition of a suitable chemical agent, or (2) to add some material which will assist the metal to absorb the gases.

It appears to be clear that the solubility of hydrogen in copper and in nickel at constant pressure increases with rise of temperature to the melting point, then suddenly increases again, and afterwards steadily rises with the temperature. On the other hand, hydrogen is very slightly soluble in molten zinc; 100 grams of zinc dissolves about 4.8 milligrams of hydrogen at 300 degress Cent., but the solubility decreases as the temperature rises, so that only 1-3 milligrams is in solution at 750 degrees Cent. Carbon monoxide is slightly soluble in copper and brass, but carbon dioxide is practically insoluble. Hydrogen dissolves in 70:30 brass to a marked extent between 500 degrees and 900 degrees Cent., and the greater portion of such hydrogen is retained on cooling. Sulphur dioxide is absorbed with reaction by heated brass, but does not lead to unsound castings, provided the metal has been properly melted and poured.

Casting Temperature of Alloys

Our attention has thus far been directed more particularly to the properties and treatment of commercially pure metals, but in practice alloys are more important. They also present more complicated problems on account of the wide variations in composition, and the changes in structure and volume which may occur.

In some experiments conducted in my laboratory by J. H. Teng, in 1918, preliminary tests were made to determine the superheat suitable for casting a series of aluminum-zinc alloys.

The following figures show the casting temperature, tensile strength, and elongation of an alloy containing 90.3 per cent of aluminum prepared and cast, in a warm iron mould, into round bars 1 inch in diameter.

Casting Temperature Degrees Cent.	Tons per Square Inch Maximum Stress	Elongation per Cent on 2 Inches
736	7.45	15
704	7.43	13
672	8.00	17

The temperatures chosen were respectively 15, 10 and 5 per cent above the liquidus of this alloy, and the result arrived at was that 672 degrees Cent. or a superheat of 5 per cent, was sufficient in this case, and that it gave better results than a higher temperature.

Industrial bronzes poured at a low heat tend to produce central piping in the runner heads, to the production of cavities in the thicker parts of the casting, and to the formation of what are sometimes wrongly called hot cracks, especially at the junction of thick and thin sections of a mold, where the metal thickness in one section exceeds that in another.

With Admiralty bronze recent researches have shown the importance of correct pouring temperature in preventing blowholes and porosity, and it is suggested that a temperature of about 1200 degrees Cent. is suitable for this alloy, since overheating to 1400 degrees produces porosity, while unsoundness frequently results from pouring below 1100 degrees.

Brass of 70:30 composition begins to solidify at about 925 degrees Cent.

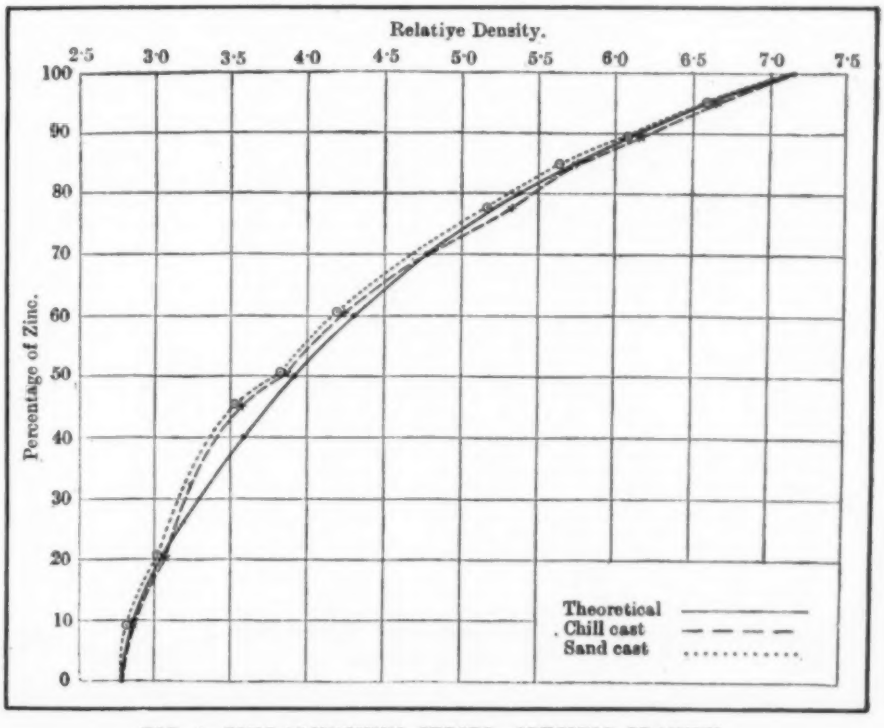

Relative Density.
2·5 3·0 3·5 4·0 4·5 5·0 5·5 6·0 6·5 7·0 7·5
Percentage of Zinc.
100 90 80 70 60 50 40 30 20 10 0
Theoretical
Chill cast
Sand cast

FIG. 4—ZINC-ALUMINUM SERIES SPECIFIC GRAVITY

cooling the metal to within 40 degrees of the liquidus, or to about 965 degrees, will certainly ruin the mechanical properties of high-grade brass which has been melted under ordinary furnace conditions. This is equivalent to a superheat of 4.3 per cent. They also suggested that when casting tubes a higher temperature was necessary than when casting solid ingots, and that for tubes of 70:29:1 composition it is not advisable to go below 1150 degrees. This corresponds with a superheat of as much as 24 per cent. Yellow brass should be cast at about 1020 degrees and Muntz metal at 973 degrees Cent., and pointed out that low mechanical tests were obtained if the pouring temperature were too high, and unsatisfactory castings if it were too low. This is in each case a superheat of about 11 per cent.

The properties of white metal bearings are much modified by differences in the casting temperature. Such alloys usually consist of tin together with relatively small proportions of antimony and copper. If the temperature is too high the compound SnSb, which separates in cuboid crystals, tends to rise and collect in the upper part of the casting, especially when the percentage of copper is low. A much better result is obtained by pouring the alloy at a temperature only slightly above its melting point, since the cuboid crystals are then more evenly distributed.

Phosphor-bronze is susceptible to variations in pouring temperature and rate of cooling. This alloy varies in tin and phosphorus content; but taking a standard mixture with about 10 per cent of tin, and 1.5 per cent of phosphorus, solidification would commence in the neighbourhood of 1000 degrees Cent., and a suitable pouring temperature would be about 1125 to 1150 degrees, or a superheat of 12.5 to 15 per cent. If poured outside that range the alloy is apt to be unsound.

The first essential to success in metal casting is to have the metal dead melted and at a suitable temperature before pouring it into the mold. In the mold there are many conditions which require consideration, such as size and disposition of the gates and runners, the moisture and porosity of the sand, the character of the dressing employed, and the rate and manner in which the metal is poured.

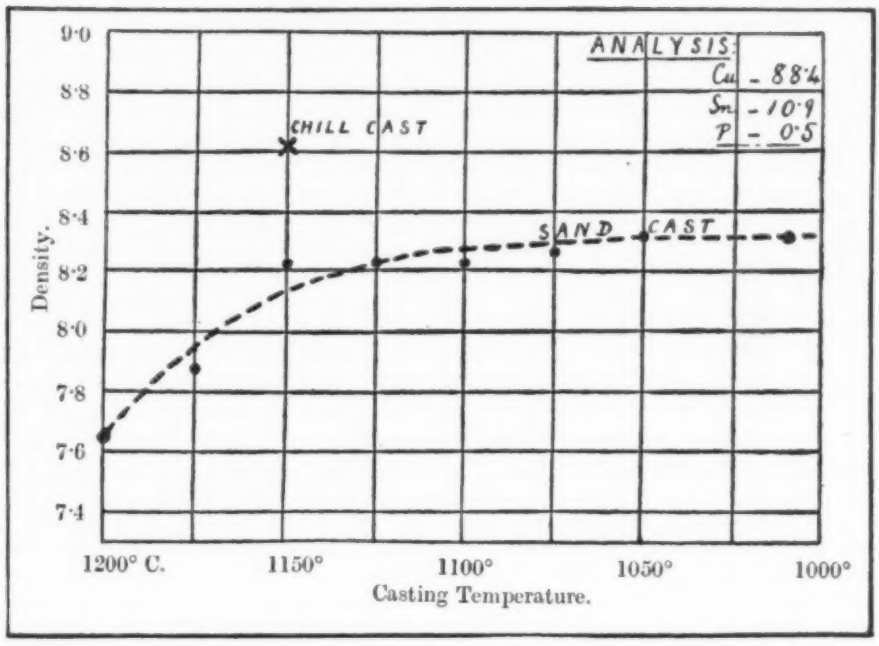


FIG. 6—DENSITY OF PHOSPHOR-BRONZE CAST AT DIFFERENT TEMPERATURES

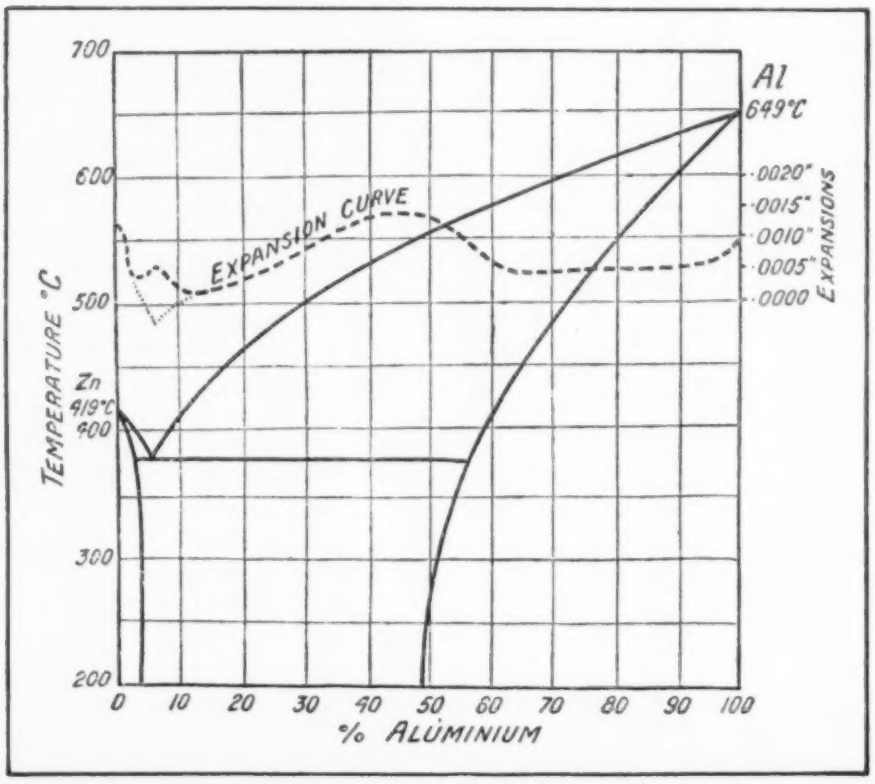


FIG. 5—EQUILIBRIUM DIAGRAM OF ALUMINUM-ZINC ALLOYS (SHEPHERD) AND MAXIMUM EXPANSION (EWEN)

Contraction and Shrinkage

In considering the volume changes which take place while the hot fluid metal passes into the cold solid casting two words are employed which originally have practically the same meaning, namely, contraction and shrinkage. Unfortunately those who have written on this subject have not always used the words in the same sense. The term shrinkage was introduced, so far as I am aware, about thirty-five years go, by W. J. Keep, who was the inventor of a system of testing generally known to foundrymen as "Keeps's test." I always have followed Mr. Keep in applying the term shrinkage to the proportional difference between the length of a casting and that of the mold in which it was produced. In other words, it is the net contraction from the moment when solidification begins in the mold. In Keep's standard test a ½-inch square bar is cast in sand, between iron yokes, which are exactly 12 inches apart. The cold bar is afterward placed in the yokes between which it was cast, and a graduated wedge is inserted so as to measure the distance between the end of the bar and the yoke. This distance is the shrinkage. The term contraction is restricted to that portion of the diminution in volume which occurs while the cooling metal is still fluid. To

Table I

Density of Alloys

Tin	Lead	Lead per cent	Weight, oz. avoir. per cubic foot
1	0	0	7170
32	1	3	7321
16	1	6	7438
10	1	9	7492
8	1	11	7560
5	1	16.5	7645
3	1	25	7940
2	1	33	8160
1	1	50	8817
0	1	100	11270

make the difference more clear it is sometimes referred to as liquid contraction.

Keep appears to have been the first to employ an extensometer of reasonable accuracy on foundry tests. In his method two iron pins were placed in a sand-mold, at a known distance apart, and the metal to be tested was poured into the mold to surround the lower part of the pins and embed them in the metal. Immediately upon solidification the bar began to contract and the pins were drawn closer together by two levers and a rotating drum and a record was obtained in the form of a time-contraction curve. Some extremely interesting and valuable results, of an exploratory nature, were obtained; but as no corresponding temperature observations were made it was not possible to correlate the observed expansions with the internal changes which were in progress.

Extensometer Tests

In my own experiments the castings were made in a sand-mold and one end of a *T*-shaped bar was fixed, while the movement of the other end was recorded by means of an extensometer. The simple form of instrument shown in Fig. 1 was quite suitable when working with cast iron, but a more accurate arrangement, with mirror and chronograph, was necessary for such tests as those of the antimony-lead series, where the changes in length were relatively very small. In all cases temperature readings were taken by means of a thermocouple and accurate galvanometer.

With white cast iron only one small expansion was observed at about 700 degrees Cent. corresponding with the separation of iron carbide from austenite with the production of pearlite. With grey phosphoric cast iron three marked expansions were observed, due to the separation of primary graphite, of the phosphide eutectic, and of secondary graphite respectively. These expansions correspond with definite alterations in density and physical properties in the casting. They also account for many of the fractured castings which are met with in practice, especially such as are due in some part to faulty design.

In testing nonferrous metals and alloys results were obtained which were more varied, and which at the time were more difficult to explain. The shrinkage tests, employing Keep's graduated wedge, showed that the shrinkage of alloys usually was less than the mean shrinkage of the constituents, and that the result obtained varied somewhat with the thickness of the bar. In other words, the rate of cooling of the casting, in the mold, affected the resultant volume. In some cases, however, thick and thin brass gave practically similar results.

Table II

Lead-Tin Alloy

Lead	Tin	Increase of bulk in thousandth parts
9	1	26
8	2	40
7	3	48
6	4	47
5	5	46
4	6	45
3	7	43
2½	7½	39
2	8	33
1½	8½	30
1	9	23
½	9½	14

In the extensometer tests it was observed that with pure metals no expansion was recorded, except some relatively small values, such as might be due to gas bubbles or the reheating of the original thin chilled skin owing to diffusion of heat from the interior. In passing through a series of alloys, cast in sand as described, it generally was found that definite and well-marked expansions were observed, though it not unfrequently was noted that certain alloys, like pure metals, showed no expansion in the sand-mold. Where the interval between liquidus and solidus on the constitutional diagram is considerable, there usually was a considerable expansion; while at any point where liquidus and solidus met, the expansion tended to disappear.

Density of Alloys

R. Watson, in 1786, said: "When two metallic substances are melted together it seldom happens that a cubic inch of each of the two ingredients will form and make two cubic inches; the mixture will in some instances be greater, and in others less than two cubic inches. Dr. Watson quotes from Glauber's works (fol. edit. 1689, p. 81) to prove that contraction takes place when tin and copper are alloyed, and adds: "In the instance of tin and copper where the bulk of the mixture is so much less than the sum of the bulks of the two component parts, it might be expected that the compound metal would possess properties not merely intermediate between those of copper and tin, but essentially different from them both. And accordingly we find, that this mixture is not only more brittle, more hard, and more sonorous than either copper or tin, but is more dense than either of them." Dr. Watson himself performed experiments on the density, at 60 degrees Fahr., of the tin-rich portion of the series, and his results are shown in Table I.

He does not say how his alloys were prepared and cast; but from the close agreement with the theoretical values it is probable the alloys were quickly cooled.

About 120 years ago the French Government desired to make a legal standard for the quantity of pewter based on specific gravity, and the following is an extract from the report presented:

Mixtures of tin and lead were found to possess less specific gravity than would have been obtained by calculation; consequently these two metals, instead of penertating each other respectively, increase in bulk when mixed together.

The law of that increase, as far as

Table III

Calculated and Observed Density

Percentage of zinc	Calculated density	Chill castings	Sand castings	Difference, chill-sand
nil	2.694	2.694	2.694	nil
9.86	2.872	2.850	2.820	0.030
20.60	3.091	3.055	3.030	0.025
45.25	3.755	3.564	3.547	0.017
50.24	3.925	3.867	3.836	0.031
60.40	4.325	4.248	4.198	0.050
77.50	5.219	5.328	5.176	0.152
84.85	5.695	5.716	5.632	0.084
89.76	6.127	6.143	6.100	0.043
95.20	6.640	6.630	6.598	0.031
100.00	7.167	7.167	7.166	nil

Table IV

Density of Aluminum

Aluminum per cent	Sand castings	Chill castings	Rolled bars ½ inch diameter
0.10	8.99	8.90	8.92
1.06	8.79	8.77	8.78
2.10	8.54	8.61	8.62
2.99	8.44	8.47	8.47
4.05	8.29	8.31	8.31
5.07	8.16	8.18	8.18
5.76	8.04	8.07	8.07
6.73	7.94	7.96	7.95
7.35	7.85	7.86	7.85
8.12	7.79+	7.78	7.78
8.67	7.73+	7.69	7.69
9.38	7.64+	7.61	7.61
9.90	7.60+	7.56	7.56
10.78	7.45	7.45	7.45
11.73	7.19	7.34	7.35
13.02	6.98	7.23	7.23

it can be deduced from experiments is shown in Table II.

Theoretical Density of Alloys

It might appear at first sight that the density of an alloy would be the mean of the densities of its constituents, when allowance has been made for the percentage composition by weight. Thus, for example, if the alloy consist of 50 parts by weight of metal of specific gravity 2, and 50 parts by weight of metal of specific gravity 10, the density would be

$$\frac{2 + 10}{2} = 6.$$

If we consider 100 grams of the above alloy, it would be made up of 50 grams of a metal with specific gravity 2, or, in other words, of 25 cubic centimeters of this metal; it would also contain 50 grams of the metal with specific gravity 10, which would occupy a volume of $\frac{50}{10}$, or 5 cubic centimeters. The whole volume would therefore be $25 + 5 = 30$ cubic centimeters, and the density will be $\frac{100}{30}$, or 3.33, and not 6 as previously suggested. The result of this is that whenever two substances which differ in density are mixed together, and the theoretical density (assuming there to be no expansion or contraction) is represented on a density-percentage weight diagram, the result is not a straight line but a curve. This curve is hyperbolic in character. To determine whether contraction or expansion has occurred, it is necessary to note the relative volume of the metals, first when separate and second when alloyed together. A simple method of making the necessary calculations is by ascertaining the number of cubic centimeters occupied by each metal in a given weight of the alloy, as in the example previously given.

As illustrating the above principles, the theoretical relative density of the aluminum-zinc series calculated at intervals of 10 per cent is as follows:

Percentage of Zinc	Relative Density
nil	2.6940
10	2.8710
20	3.0788
30	3.3120
40	3.5920
50	3.9153
60	4.3071
70	4.7860
80	5.3891
90	6.1455
95	6.6156
100	7.1665

These values are for metal and water at 15 degrees Cent., and they are graphically represented in Fig. 4.

Effect of Rate of Cooling

In the series of experiments conducted in my laboratory casts were prepared in the form of round rods of 1-inch diameter, one series being chilled by casting in an iron mold, while the others were cooled more slowly by casting in sand. The result of the experiments is given in the following table, and is graphically seen in Fig. 4.

It will be observed that:

1. In the case of the pure metal the density of the sand and chill castings were alike to three places of decimals. Any small difference which was observed only occurred in the fourth decimal place, which is well within the limit of experimental error.
2. In each set of experiments the alloys gave higher values in the chill casting than in the sand casting.
3. The general agreement between the results and the theoretical value is good, though between about 75 and 90 per cent of zinc the chill castings are slightly more dense than the theoretical value, while they were less dense in the middle of the series. The increase of density corresponds with the formation of the compound Al_2Zn_3.
4. The lower density in the middle of the series, and the higher density toward either end as compared with the theoretical curve, is in accordance with the results of observations with the extensometer by Ewen and Turner. (see Fig. 5). The maximum expansion observed on the extensometer corresponds with the maximum solidification interval, as shown on the constitutional diagram of the series by Rosenhain and Archbutt. The contraction due to the formation of Al_2Zn_3 is also indicated on the extensometer curve.

The agreement between the calculated values for the density of zinc-aluminum alloys, assuming that there is no alteration of volume, is very close to that which actually is observed. The differences are, in fact, too small to be shown distinctly on a diagram of moderate size. The subject has been studied by Rhodin and by B. W. Hales and it has been suggested that the relative amount of the two metals, and also of copper, which does not differ so very largely from zinc, may be estimated for commercial purposes by density determinations.

The accompanying table IV gives the results of experiments by Carpenter and Edwards to determine the density of alloys containing from 0.10 to 13.02 per cent of aluminum.

The following conclusions are to be drawn from the recorded data:

1. Throughout the series chill-cast bars give results which are in close agreement with the calculated density.
2. That in all cases examined there was close agreement between the density of the chill castings and the rolled bars.
3. The sand castings had a lower density than the chill castings, except with from about 8 to 10.8 per cent of copper.
4. This exceptional result of a slowly-cooled bar actually giving a greater density than a rolled bar is associated with the fact that over this range of composition the compound Cu_2Al exists in the slowly-cooled bars, and the structure is duplex instead of being homogeneous. The change of structure is therefore registered in the altered density. If it is assumed that the compound Cu_2Al dissociates, with increase of volume, at higher temperatures, the anomaly is explained.

Effect on Other Alloys

The following experiment, illustrates the effect on the density resulting from slow or rapid cooling of a common

brass. The composition of the metal was as follows:

	Per Cent
Copper	63.98
Zinc	34.85
Lead	0.77
Iron	0.34
Tin	0.06

When the alloy had been melted, sand castings and chilled castings were prepared, side by side, from the same pot, at the same time. The castings were rods of about 1 inch diameter. The results obtained were as follows, the metal and water being at 15 degrees Cent.:

	Sand Cast	Chill Cast
Top	8.463	8.722
Middle	8.469	8.719
Bottom	8.471	8.730
Average	8.468	8.724

The calculated density from the above composition, assuming no volume change, is 8.08. Hence the contraction of volume, due to combination when the metals were alloyed, was about 7.7 per cent, while the expansion due to slower cooling was 2.95 per cent. The extensometer shows that bars of this composition, when sand cast, give a distinct, though relatively small expansion. In this particular series some of the alloys, such as those with about 15 per cent copper, give very marked expansions indeed, as may be noted.

It is evident that slow or rapid cooling are merely relative terms, and that more information is required on the effect of initial temperature and rate of cooling.

There is little doubt that the comparative failure, in recent years, to connect the density with the composition and structure of alloys has been due, ot least in great measure, to a want of recognition of the difference which exists, in many cases, between slowly and quickly cooled alloys.

The general rule appears to be that when there is no crystallization interval the density is the same whether the metal or alloy is slowly or quickly cooled. But where there is a crystallization interval (*i.e.* where the liquidus and solidus are separated) sandcast bars give a lower density than chill cast, and also show expansions if examined by the extensometer.

In the United States investigations were made and records obtained in reference to the casting of aluminum alloys. The conclusions reached were that the number of blowholes increased as the pouring temperature was raised, as the temperature in the furnace was raised, and as the length of time taken in melting increased. Among the other causes of trouble reference was made to failure to skim the pot properly; collection of foreign matter, solid or gaseous, from the mold, as a result of wet molds, poor molds, bad venting or bad pouring; and to faulty pattern design resulting in shrinkage holes or cracks.

In one large foundry, with a total loss of 13.92 per cent, the chief causes of rejection were:

	Per Cent
Due to cores	2.30
Due to moulding	3.22
Cracked	2.27
Broken in handling	1.76
Mis-run or run out	2.18
Other causes	2.19

An examination of such figures shows the absolute necessity of care and skill on the part of the foundry operatives. The man with scientific training can explain the following fundamental principles which underlie the industry, and assist in ascertaining and removing the causes of failure. But in the final operations success or failure depends upon the skill, attention, and devotion of the experienced workman, who as a result of years of training has acquired a knowledge which he is often unable to express in words, but which it is the desire of every true craftsman to impress upon the product which is the outcome of his combined labor and skill.

New England Foundrymen Consider Costs

THE present period of reduced production at many plants, emphasizes the importance of a cost system and brings into prominence many problems which do not appear in normal times, according to C. I. Drake, assistant to the president, Walworth Manufacturing Co., Boston, who addressed the November meeting of the New England Foundrymen's association. Cost systems in a foundry, continued Mr. Drake, are necessary for several reasons. First, they furnish the only positive means of pricing the plant's output correctly. Second, they are necessary to fix responsibility in different parts of a plant. A cost system of itself will not improve conditions, but it furnishes the means of accomplishing much. Through it, necessary waste may be eliminated and many costly operations may be avoided. Without a system of costs, it is impossible to tell whether one class of castings is making or losing money, even though it is fairly certain that the plant as a whole is showing a profit. One foundry making pulley wheels found after adopting a rigid cost system that all wheels below a certain size were made at a loss. Therefore, the small size wheels were placed with an outside foundry with the net result of a 10 to 15 per cent profit.

One of the greatest stumbling blocks in any cost system is the overhead, and yet for this reason it is here that the biggest savings may be made. All items in overhead which can be traced directly to different departments should be individually distributed. General items which cannot be applied in any direct sense to departments, should be distributed, Mr. Drake believes, according to the relative payroll expense in each department.

Costs must be determined for classes or groups of castings, where a large variety prevails. Some foundries have arrived at costs segregated to customers, but this as a rule is unsatisfactory and often results in the foundry securing the less desirable castings while a competing foundry gets the more profitable work. Classification often is made by weight, that is, all castings coming between one and ten pounds following one class; eleven to fifty in another class, etc. At the Walworth Manufacturing Co., classification is made according to nature of the castings. For example, one group covers screwed elbow fittings. Another, a certain type of valve and so on, through the company's entire product. The nature of the classification must be determined for each individual foundry. In a jobbing foundry, it often is advisable to classify costs on individual patterns.

The cost system to be successful must be used, and the extent to which the information secured is made available for those needing it for use, is the extent to which the system will pay. In the discussion which followed Mr. Drake's paper, the chief question seemed to be, what to charge for castings during dull times or when plants were operating at from 10 to 30 or 40 per cent of normal capacity. Mr. Jordan of the Whitcomb-Blaisdell Co., Worcester, said that in normal times he knew approximately what his castings cost, and based his prices accordingly, but that at present if he based his prices according to cost, his company would get but little business.

Mr. Drake said this is one of the questions now being discussed by cost accountants. In many cases it stands to reason that the total overhead in dull times cannot be distributed throughout the production departments and then have price fixing determined by cost.

Germans Jar Molds Mechanically

Comparison Is Made of Different Methods of Packing the Sand in Molds and Mechanical Jarring Machines, Both with and without Shock Absorbers Are Described in Detail

BY U. LOHSE

TO MAKE a good casting, it is necessary to ram the sand in the flask to the proper density. To do so by a machine has been the goal of the molding machine manufacturer since the appearance of the pattern board. The endeavors to replace the hand ramming which gives a good mold due to the care exercised, by machine ramming, have been successful only in connection with molds for pipes. In other molding machines pressing or squeezing is substituted for ramming. This method is now generally used for packing the sand in spite of the difficulties encountered when making deep molds with patterns of intricate shapes, difficulties which cannot altogether be eliminated, although they may be partly reduced by a suitable design of the machine.

In view of the fact that hand ramming consumes about 50 per cent of the total time required to make the mold, that the molder must be experienced and careful, and that it is fatiguing, it is only natural that efforts should have been made to do the ramming by a machine.

The requirements for ramming are the following:

The sand must be rammed uniformly.
The sand must be firmly packed in the different parts of the mold.
Molds made from the same pattern must be uniform in appearance.

Jarring Insures Uniformity

If the first requirement, of which the other two are dependent, is not complied with, the following troubles will be experienced: opening up of the mold, the appearance of scabs and pipes on the casting and sometimes leaking of the mold.

To obtain a uniform firmness of the surface of the mold when ramming by hand is difficult. If hard and soft spots occur together, the gases will be drawn to the soft spots instead of penetrating the sand evenly. During the pouring, the sand will then give way at the places possessing the least resistance and

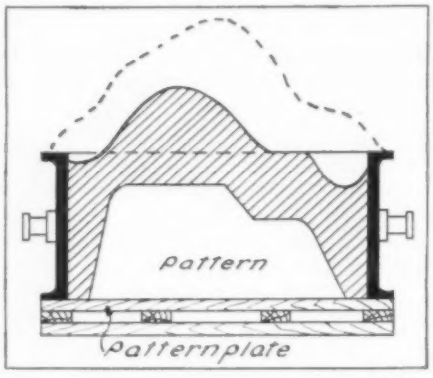


FIG. 1—FORM OF SAND AFTER JARRING, UNSUITABLE FOR RAMMING

the result will be a casting with a rough surface. Moreover, castings from the same pattern poured in hand-rammed molds, show often a variation in weight of 5 to 10 per cent.

All these difficulties and nonuniformities are disposed of by imparting the proper density to the sand by jarring. At the shock following each jolt the sand continues to move downward while the movement of the pattern board and the flask is instantly arrested. In this way the maximum density of the sand is attained at the surface of the pattern. By repeated shocks the sand is made to flow toward the bottom of the mold and becomes packed evenly around the pattern and the corners of the flask. The jarring effect of the machine induces the grains of sand to move in the direction of the least resistance resulting in a uniform density in the different horizontal layers and the absence of adjoining hard and soft spots in the same layer. The jarring therefore fulfills all three of the abovementioned requirements, besides speeding up the packing of the sand, which requires only 5 to 30 seconds, depending on the size of the mold, i.e., only a small part of the time required to make the complete mold.

The two curves in Fig. 2 represent the densities of the sand in the different horizontal layers in jarred and pressed molds. As may be seen, the density in the jarred molds is greatest at the pattern board and the pattern, and decreases as the distance from the board increases, while the opposite holds true in the latter kind of mold. The density of the sand obtained by the jarring is therefore in good conformity with the requirements of packing molding sand in general. The surface of the mold will be hard and dense, while the following layers will gradually become more porous so that the escape of the gases will not be interfered with. It is therefore not necessary to vent with a wire in a jarred mold, something which must be done in a squeezed mold. Jarring machines are suited for all kinds of castings from a certain height upward. To jar molds of a depth of less than 11 inches is not advantageous as in such a case it is necessary to use a filling frame, also to ram it afterwards in order to make the top of the mold sufficiently hard. In connection with low molds it is therefore better to employ squeezing.

Ram Sand After Jarring

Even with deep molds it is necessary to ram the sand after jarring if filling frames are not used. This latter method is, however, not to be recommended, as striking off of the surplus sand which is comparatively hard, means an expenditure of both time and muscular effort. It is, therefore, preferable to ram it.

If the sand be left to itself during

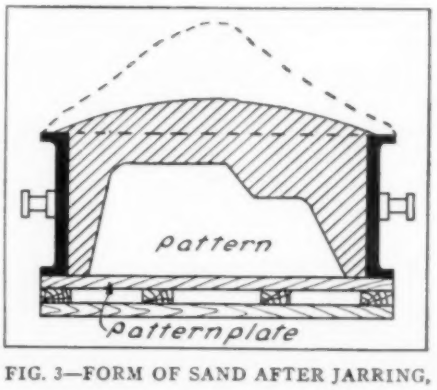


FIG. 3—FORM OF SAND AFTER JARRING,

Abstracted from *Stahl und Eisen*, Sept. 1, 1921.

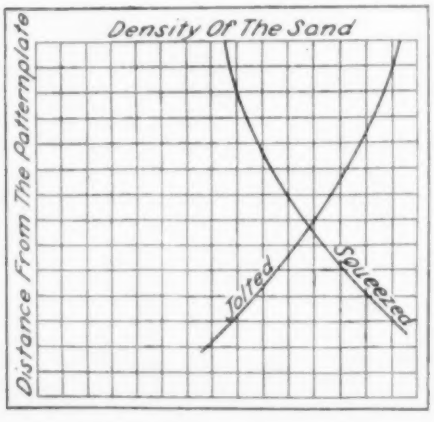


FIG. 2—DENSITY OF SAND

the jarring, it will assume a form as shown in Fig. 1, while the outline from the beginning was like that indicated by the dotted line. Now before the ramming can be commenced, the sand must be distributed more uniformly over the flask, something which requires a certain amount of time. The best way to proceed is to spread the sand with the hand during the jarring so that the surface, after the jarring is finished, assumes the form shown in Fig. 3. The ramming can now take place immediately. For molds of average size only about one minute is required for this work, as it is not necessary to aim at a great uniformity, but rather to make the surface of the sand sufficiently hard to prevent it from falling out when the mold is inverted. Only when it is desired to obtain a particularly accurate agreement between castings of identical shape, for instance automobile parts, the ramming must be performed with a certain care. For such molds the jarring machines in the United States are provided with squeezers to pack the sand. This tends, however, to make the machines more complicated and expensive, and it may be doubted whether it is not preferable to dispense with this combination of squeezer and jarring machine, and instead ram the sand afterwards somewhat more carefully, even if some extra time must be expended on this operation.

Must Prevent Vibration

It is particularly important to see that the pattern board lies flat upon the platen and is securely fastened to it so that it cannot itself vibrate which would tend to fracture the mold.

It also is necessary to prevent a rebound of the platen after the shock, as the sand in the mold would be loosened in such a case and the effect of the shock thus would be partially nullified. Therefore, it is advisable to provide for a certain compression in the cylinder at the reversal of the stroke so as to prevent such a rebound.

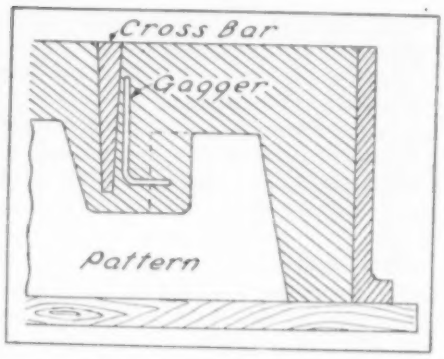


FIG. 5—POSITION OF GAGGERS SUITABLE FOR RAMMING

If the plunger together with the platen and the flask descends at a higher velocity than that caused by fall by gravity the sand will move slower than the flask, which will tend to loosen the sand.

Another factor to be taken into consideration is the ratio of the diameter to the length of the plunger. If this ratio is too small the plunger will press against that part of the cylinder which is underneath the heavier part of the mold, and a rebound of the lighter part is likely to occur, especially when the area covered by the mold is wide and it is supported by the cylinder head. The packing of the sand will then proceed unevenly. The greater the length of the plunger, the less the danger of the plunger pressing against one side of the cylinder. If molds are to be made on the same platen for different metals which require different densities of the sand, the stroke must be variable, which may easily be attained by adjusting the valves.

For small and medium sized molds it is preferable to employ cast-iron flasks, cast in one piece, while for large molds it is better to use wrought iron flasks. If necessary, gaggers may be used which then are placed against the ribs of the flask, as shown in Fig. 5. To increase the effect of these, it is recommended to dip them in wet clay before insertion.

Apply to Almost Any Pattern

Jarring can be applied to almost any pattern, although the pattern may have to be changed somewhat. Even pieces with under surfaces present no obstacles when the jarring is done correctly. The question whether a mold should be jarred or squeezed is therefore dependent more on the depth than on the shape of the pattern. As already mentioned flat molds should preferably be squeezed.

If the jarring machine is to be efficiently utilized, mechanical conveying of sand to the machine must be arranged for when medium sized or large molds are to be made. As the advantage of these machines lies in the rapid molding and filling of the flask with sand by hand, it is evident that the machine in such a case will be idle a long time in proportion to the total molding time, and its efficiency therefore low.

The jarring machine also may be combined with lifting mechanisms. According to the kind of pattern used, either turnover, lifting or stripping devices may be employed. If the pattern can be lifted easily by hand special lifting devices may be dispensed with. This is done in connection with small jarring machines on which small and medium size cores can be made by using suitable core boxes.

The jarring movement is produced mechanically by means of an electric motor or belt drive, as well as by compressed air. In the latter case two different devices may be employed. The

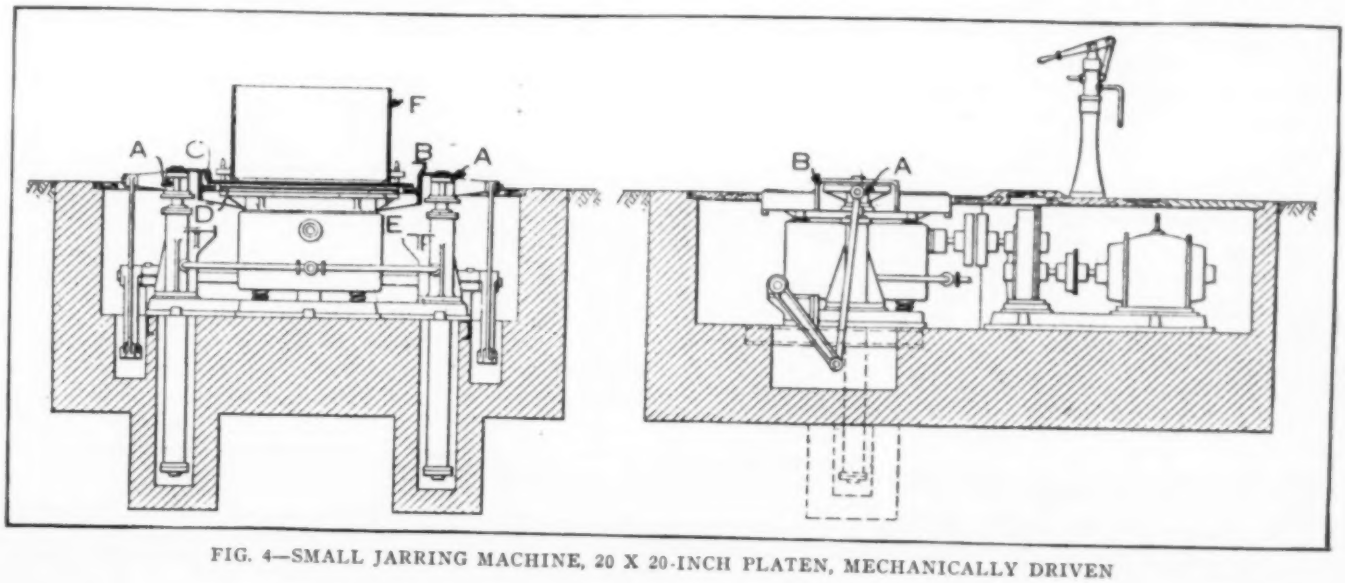


FIG. 4—SMALL JARRING MACHINE, 20 X 20-INCH PLATEN, MECHANICALLY DRIVEN

cylinder is either resting on the foundation, in which case the plunger together with the platen is movable, or the cylinder is fastened to the platen and is moved up and down over the stationary plunger.

Shock Absorbers Necessary

When the shock must be increased to make heavy molds it is necessary to provide for this shock being absorbed in the machine itself. If these violent shocks should be transmitted through the foundation to the floor of the shop, the molds already finished might be damaged and even the building itself might suffer. It was not until it became possible to build shockless—or rather shock absorbing—jarring machines that this type of molding machine attained any rapid development. However, the necessity to absorb the shock is dependent not only on the size of the mold but also on the condition of the ground. If this is hard and rocky, so that in its natural condition it does not transmit vibrations readily, any special arrangements to absorb the shock may be dispensed with, while with unsuitable ground such devices will be necessary even for medium sized molds.

Types of mechanical jarring machines made by German firms may be divided into two classes according to whether they are provided with shock absorbers or not.

The first class considered are mechanical jarring machines without shock absorbers. The small jarring machine, Fig. 7, built by Leber & Brose G. M. B. H., Coblenz, Germany, has a platen surface 20 inches square and consists of a cylinder, *A*, cast in one piece with the base plate. The plunger, *B*, which supports the platen is raised in this cylinder by means of the knob, *C*, and allowed to drop whereby the shock is obtained by the impact of the platen on the cylinder at *D*. To prevent the plunger from turning in the cylinder, two guide bolts, *E*, are screwed into the head of the plunger and move up and down in holes in the flange of the cylinder. The knob *C* is mounted on the shaft *F* which is supported by two bearings in the base of the cylinder and in one outside bearing. The fast pulley, *H*, and the loose pulley, *I*, situated beside this latter bearing, are operated by means of a belt. There is nothing to prevent an electric motor being used instead of the belt drive. In such case, however, the number of revolutions of the shaft, *F*, must be reduced by means of gearing. The knob, *C*, is encased in oil to lessen the friction, and lubrication is provided for wherever this is necessary. The machine is simple and requires little attention.

Pattern boards and flasks are mounted on the platen. The lifting of the finished mold is done by hand. If so desired, the whole machine may be mounted on a shock absorbing base.

Mechanical Jar With Shock Absorber

The electric jarring machine shown in Fig. 6 is built by Vereinigte Modellfabriken Berlin-Landsberg A. W., G. M. B. H. It possesses a mechanical device for turning over the pattern board, and hydraulic lifting arrangement. The illustration on the left hand shows a longitudinal section and that on the right hand a cross-section through the center of the machine. In this latter section the right half shows the rollover table in its original position on the platen, and the left half the same table is lifted up and turned over.

Electric Drive

The base plate, *A*, of cast iron supports four guide pillars, *B*, for the anvil, *C*, which in its turn rests on the spiral springs, *D*. The anvil supports the platen, *E*, which is guided during its movements by the plungers, *F*, in the pillars, *B*.

On both sides of the base plate, *A*, two hydraulic lifting cylinders, *G*, are mounted. Plungers support the bodies, *I*, of the bearings, *K*, for the rollover table. These bearings for the table are made to glide in suitable grooves. The right hand body is provided with a worm gearing, to turn the table, consisting of the casting, *M*, the gear wheel, *N*, and the worm, *O*. The main driving shaft, *R*, is mounted in the bearings in a special casing filled with oil in the interior of the anvil. An outside bearing is also provided. The knob *S* is attached to the shaft in the oil casing and by working against the steel rollers, *U*, mounted in the bearings, *V*, lifts the platen. The main driving shaft is by means of the safety coupling connected to gearing which in its turn is connected through a second safety coupling to the driving motor.

In order to enable the pattern to be lifted accurately by the hydraulic plungers, these are connected by means of the

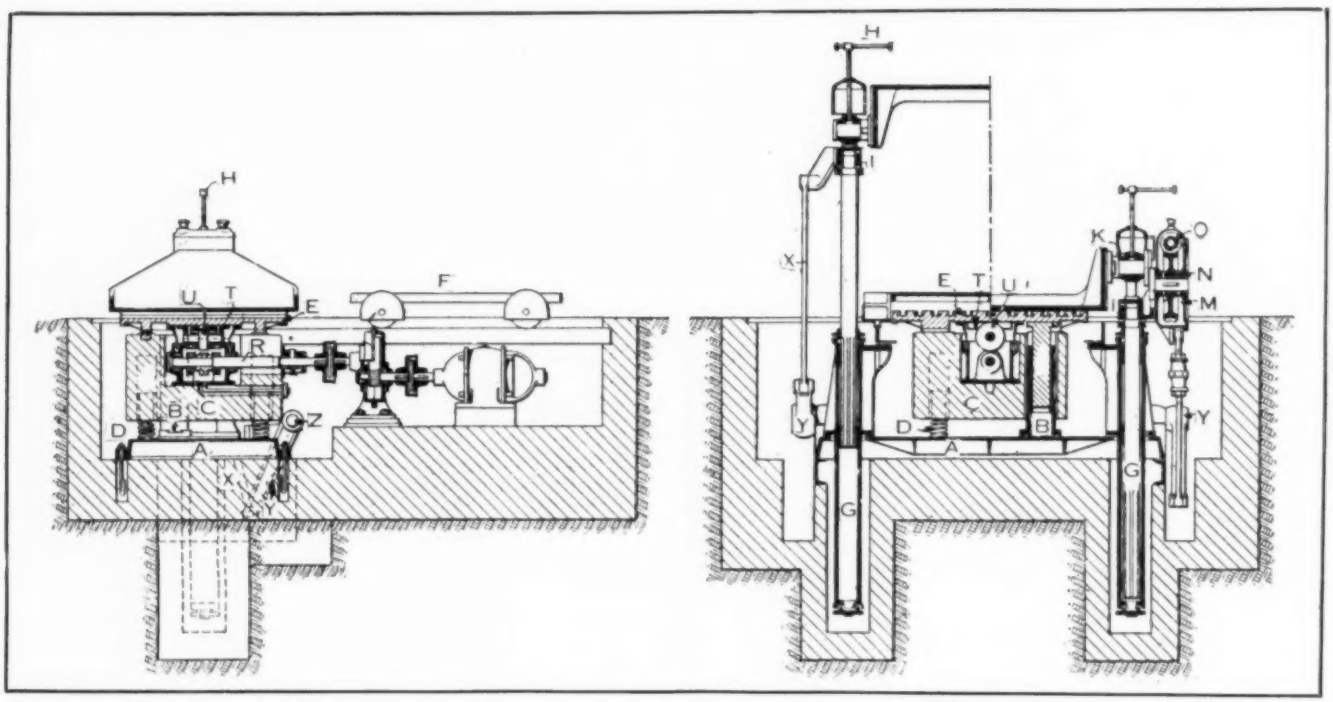


FIG. 6—ELECTRIC JARRING MACHINE WITH SHOCK ABSORBER, TURN-OVER TABLE, MECHANICAL TURN-OVER AND HYDRAULIC LIFTING DEVICE

rods, *X*, the levers, *Y*, and the connecting shaft, *Z*, so that they can be raised and lowered simultaneously and evenly. The car, running on the track, is used for taking out the finished molds. The screw and lever arrangement, *H*, is for the purpose of holding the rollover table in position when the mold is lifted out. When tightened, these screws press against brake shoes, which prevent the journals on the rollover table from turning. These journals are bolted to the sides of the rollover table. When the plunger is in its highest position the center of the journals is on the same height as the center of the worm wheel, *N*. During the jarring the turning device remains in the position shown at the right of the illustration. The connection between the worm wheel and the right hand journal of the rollover table is accomplished by means of a kind of groove with a spring which permits of raising and lowering the rollover table with the worm gearing stationary. The movable parts of the machine are in dust-proof casings and provided with easily accessible oil cups.

The operation of the machine is as follows: The flask is set upon the table and suitably fastened. After a filling frame has been set up, the depth of which is governed by the depth of the pattern, sand is filled in. The rollover table is attached to the platen during this operation. After starting the motor the platen is elevated and then allowed to drop on the anvil. After the jarring is finished which requires about one minute, the motor is stopped.

After the filling frame has been taken off and the top of the sand lightly rammed with a flat rammer, the surplus sand is struck off. The valves are now opened and the turnover table raised by means of the hydraulic plungers until it has reached its highest position. It then is turned 180 degrees by means of the worm gearing so that the now finished mold hangs on the rollover plate with the top down. The car is run underneath and the mold lowered on this. The flask is now disconnected from the rollover table, the water turned on again, and the pattern withdrawn from the sand. The mold is then taken out on the car from the machine.

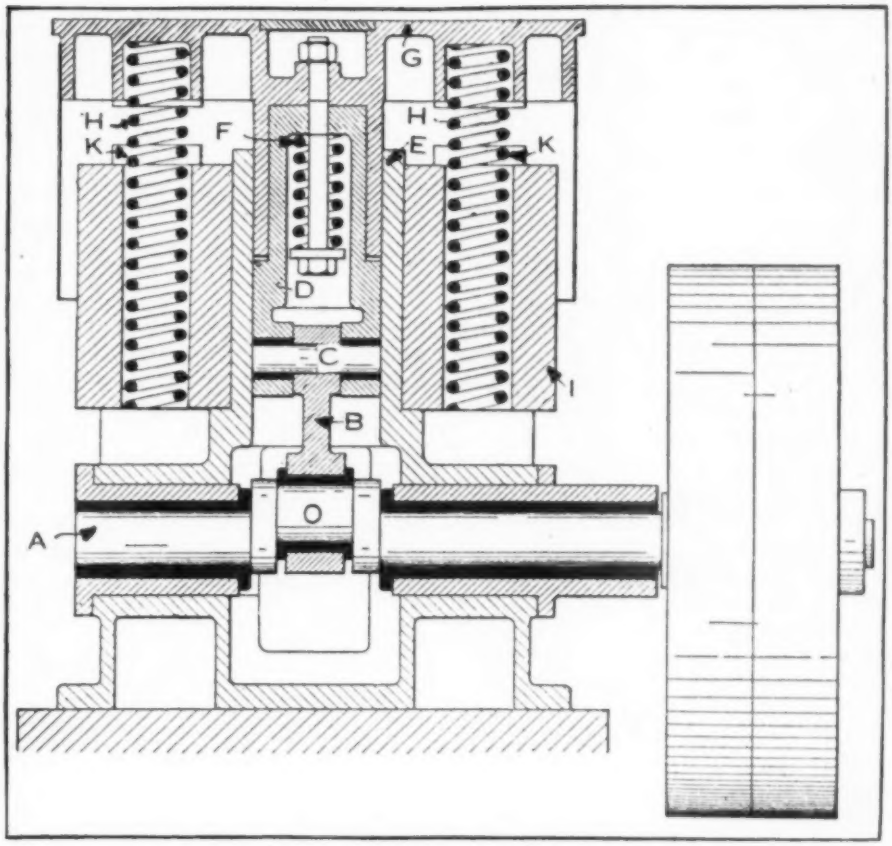


FIG. 8—PULL-DOWN JARRING MACHINE WITH BELT DRIVE

Instead of the motor, a belt drive with fast and loose pulleys may be used, in which case the intermediate gearing is omitted.

Instead of a rollover table with a lifting device, the same kind of machine may also be used with stripping plates as shown in Fig. 4. The jarring and lifting mechanism is the same as described above. Instead of the bearings for the rollover plate, however, the lifting frame, *B*, is fastened to the top, *A*, of the plunger and this frame is in turn attached to the stripping plate, *C*, resting on the pattern board, *D*. This board is attached to the platen, *E*. When the sand has been packed, the flask and the plate are disconnected, the water pressure applied, and the frame then lifts the stripping plate with the mold and thus accomplishes a separation of the mold and the pattern. The finished mold is then taken away by hand or by a crane.

With the smaller sizes of the machines described above the movement of the lifting frame and the rollover table are accomplished by hand-operated levers, while with the larger sizes this is done

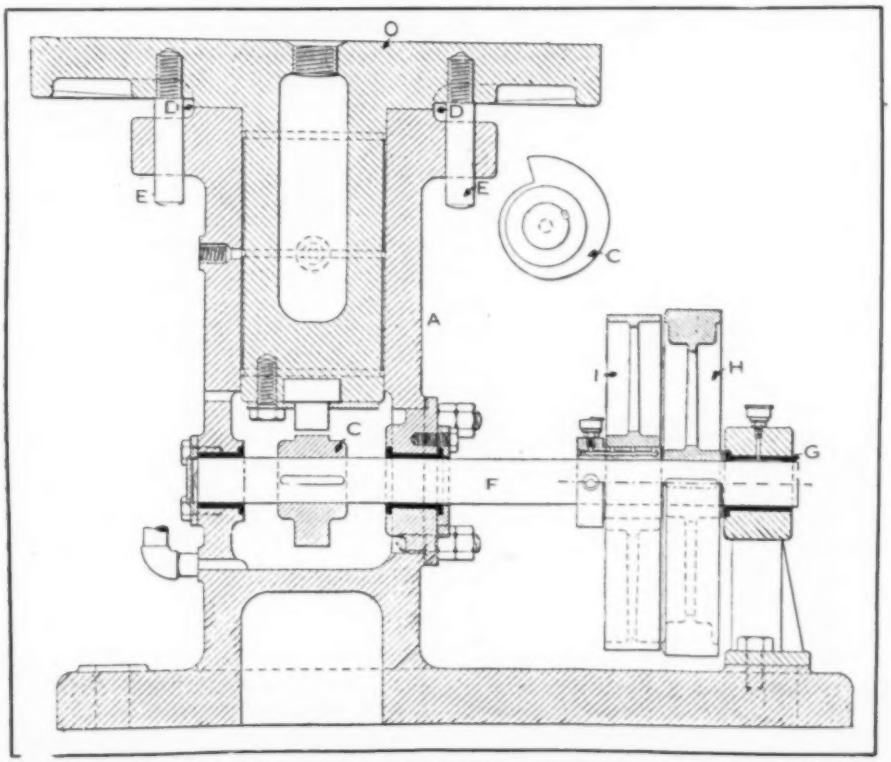


FIG. 4—JARRING MACHINE WITH SHOCK ABSORBER, LIFTING FRAMES AND HYDRAULIC LIFTING DEVICE

by means of racks and pinions, operated by hand in a similar manner to the appliances used on the ordinary hand and hydraulic molding machines.

The pull-down jarring machine, type Oettling, Fig. 8, built by Vereinigte Schmirgel-und Maschinenfabriken A.-G., Hanover-Hainholz, is also a jarring machine with shock absorber. This machine was designed with a view to eliminate the power required in other machines to raise the pattern board and the platen with the flask and the sand, to a certain height in order to let it gain sufficient momentum during the drop to produce the necessary shock. The designer reasoned that with this method of producing the shock much dead weight must be lifted, and consequently the power required for such a machine must be considerably higher than would be necessary if only packing the sand be taken in consideration. In the new design the dead weights are counterbalanced by springs and the platen is not allowed to drop, but is pulled down. To accomplish this, comparatively little power is required and this is used in overcoming the friction and the resistance of the springs. As in this machine the velocity required for the shock is independent of the acceleration by free fall, it may be changed as is desired by changing the number of revolutions of the driving shaft. The shock in this machine also is absorbed by an anvil supported by springs so that vibrations in the vicinity of the machine are not noticeable.

This jarring machine, Fig. 8, is driven by the crank shaft *A*, which is supported by two bearings in the lower part of the frame, and carries the fast and loose pulleys on one side. A geared motor may also be used instead of the belt drive. A connecting rod, *B*, connects the journal with the crank pin, *C*. This latter is placed in a plunger, *D*, which moves in a circular guide, *E*, and is by means of spiral springs connected with the platen, *G*. The cylindrical part in the center of the platen is fitted into the space between the guide and the plunger. In addition the platen rests on the spiral springs, *H*, which counterbalance the weights of the platen, the pattern board and the flask with its filling of sand. The anvil, *I*, is provided with small blocks, *K*, which receive the shock.

When the crank shaft is turned, the connecting rod pulls the plunger down. Before, however, the crank, *O*, can arrive at the dead center, the platen strikes the blocks and the spring between the plunger and the platen remains compressed until the crank has passed the dead point. As the crank continues to turn, this spring is gradually released, while the plunger moves upward and finally pushes the platen up again, the springs assisting in this work.

In order to pull down the platen all that is required is to overcome the excess of tension in the springs over and above that which is needed to hold the platen with its load in equilibrium, and to compress the springs, *F*, between the plunger and the platen. When the platen moves up, these forces are again released. The power required is therefore quite small.

Another advantage of the crank device is the easy accessibility as compared with the *fall by gravity* arrangement. In addition, the rollers between the platen and the lifting knob prevent the sudden release of the platen which is required to give an efficient shock.

The jarring machine may be provided in the usual manner with lifting mechanisms actuated by hand or hydraulic power, depending upon the weight of the mold and the size of flask employed.

Pyrometer Solves Temperature Problems

BY JOHN P. GOHEEN

CONSIDERABLE work has been done in developing a pyrometer to measure the temperature of molten brasses, bronzes, and aluminum in the crucible. On account of the high melting points and the amount of zinc and sulphurous fumes given off from molten brasses, the conditions are somewhat severe for a thermocouple of standard design; but satisfactory results are obtained with a portable pyrometer, 3 feet of connecting lead wire, and a special 5-foot nickel chromium-nickel thermocouple, composed of rods ¼ inch in diameter. The lower 12 or 24 inches, as desired, may be made detachable so that new tips may be connected at little trouble or expense. The portable instrument need not be of the extreme high-resistance type, as the movable parts of the galvanometer of a lower resistance instrument may be better constructed to withstand the continuous handling such an instrument receives. Platinum, platinum-rhodium thermocouples, protected with porcelain and graphite tubes, have been used, but the lag in registering the temperature is too great.

It has been found that the range of temperature for various brasses is as follows:

Red brasses .....2200-2250° F.
Yellow brasses .....2250-2400° F.
Bronzes .....2300-2550° F.

A recent test with a portable pyrometer having a range of 2600 degrees Fahr. with a bare ¼-inch heavy exposed couple 5 feet long and a handle attached at the upper end showed that the temperatures of molten aluminum under varying conditions in an oil-fired crucible furnace and one of the Simplex type were as follows:

	Crucible oil-fired furnace, Degrees Fahr.	Simplex furnace, Degrees Fahr.
Temperature of metal in furnace	1540	1530
Temperature in ladle after skimming at furnace	1480	1440
Temperature in ladle after skimming at floor near mold	1440	1430

A test, in a crucible furnace, of a special automobile aluminum gave the following temperatures:

	Degrees Fahr.
Temperature of metal in furnace	1305
Temperature in ladle after skimming at furnace	1295
Temperature in ladle after skimming at floor near mold	1280

It may be noted that the temperature of the metal in the first two tests dropped 100 degrees Fahr. before the time of pouring. In the third test, the larger crucible and shorter carrying distance prevented as great a drop as in the other tests. Therefore, to insure consistent pouring temperatures, the temperature at the furnace and the distance to the molds must be regulated. The size of the crucible also must be considered, as a much slower rate of cooling prevails with the larger crucible of metal. It is possible to establish a melting-point temperature that will assure correct consistency of the metal at the mold.

Electric Brass-Melting Furnace

A permanently installed electric pyrometer may be placed on electric brass-melting furnaces, and, if desired, an actual record secured of each heat. This shows the temperature at which each melt was made and also the time interval. The equipment developed for this purpose consists of a 60-day continuous recording pyrometer of the latest high-resistance type with chart range 0-2400 degrees Fahr. A record line is produced on this chart by means of a moving carbon ribbon so that a non-smearing permanent record is secured.

The thermocouple consists of extra heavy ¼-inch nickel and chromium-nickel rods, similar to those used with portable pyrometers, but permanent-

Paper to be presented at the New York meeting of the American Institute of Mining and Metallurgical Engineers, in February, 1922.

The author is secretary, the Brown Instrument Co., Philadelphia.

ly installed. These heavy ¼-inch thermocouples are protected against the severe gases by heavy porcelain tubes, which in turn are inserted in firebrick tubes closed at one end.

Compensating leads carry the cold end of the thermocouple away from the effect of the radiated furnace heat. These compensating leads may be extended to a cold-end well several feet in the ground or direct to a recording pyrometer. While the temperature of the molten metal may reach 2450 to 2550 degrees Fahr., the thermocouple, flush with the furnace lining, shows a relative temperature of the gases above the metal line.

Platinum, platinum-rhodium thermocouples were tried but the tilting of the furnace when pouring caused the lighter gage wire to break. Besides, the gases caused crystallization. The nickel-chromium as well as the platinum-rhodium thermocouple must be carefully protected to resist a zinc-oxide precipitation from the fumes of the brass at time of pouring.

Brazing Brass

In the manufacture of bow sockets for automobile use, the difficulty of brazing the socket was overcome when the temperatures in the furnace and the effect of air drafts in recharging the furnaces were regulated. A specially designed furnace with two burners directly opposite the position of the sockets to be brazed was used, giving close regulation. Ten to 15 sockets at the ends of the hollow tubes were placed in this furnace at a time. To determine the relative flame temperature and brazing temperature, the following equipment was used:

A duplex recording pyrometer having a chart divided into two sections was installed near the furnaces. Two 18-inch platinum, platinum-rhodium thermocouples in fused silica quartz tubes were connected to the recorder, using compensating leads direct to the recording instrument. One of the thermocouples was inserted in the hollow tube close to the eyelet of the socket to be brazed, a mixture of borax and brass filings having been poured down the tube as a flux. It was found that the actual temperature of the other burner, and the fire were close. The thermocouple was then removed from the tube and permanently located just to one side of the burner so that the hot end was in immediate juxtaposition to the sockets. It was found that a window immediately above the furnace, when open, permitted the air to be drawn through the opening of the furnace. An asbestos curtain was installed to prevent this.

The two galvanometer systems of several hundred ohms resistance, one for each section of chart, are mounted in a gray-iron casting, machined and enameled. As the thermocouples are connected by wire directly to each electrical system, there are no rotating switches to develop poor contact. A special 8-day clock drives the chart rolls as well as the few mechanical parts for depressing the pointer momentarily to the chart paper. A contiunous roll of carbon ribbon produces a nonsmearing dot every 30 seconds which permits the slightest change in temperature to be shown. Thermocouples of base metal or rare metal may be used.

The durability of the thermocouples depends greatly on the type of protecting tube selected. In galvanizing tanks, using a high percentage of zinc, considerable difficulty has been experienced in procuring a tube that will withstand the action of the zinc. Recently a test was made of nine types of tubes, closed at one end, installed in a galvanizing bath containing 99 per cent zinc. After two months continuous immersion, all but two of the tubes were entirely eaten through by the action of the zinc. One of the two remaining tubes was of wrought iron with extra heavy wall; the other was composed of a high chromium-iron alloy. The wall of the wrought-iron tube was quite thin, but the other tube showed little effect and would likely hold up for several months longer. Tubes of a nickel alloy rapidly gave out under the action of the spelter.

By a slight modification of the indicating pyrometer, a set of contacts may be inserted into the instrument so that by colored lights above each tank the foreman can tell at a glance just which tanks are correct and which may require some adjustment. By the substitution of a relay and valve mechanism, the temperature of the tank kettle may be automatically controlled.

Core-Oven Temperature Control

It was formerly common practice to disregard the preparation and systematic drying of the core, yet spongy castings due to blowholes or green cores were the bane of the foundry man. Modern core-oven equipment and careful temperature regulation have contributed to the betterment of the casting shop. Probably the most largely used temperature recorder on core ovens is the long-distance recording thermometer. One of the insturments should be used for each oven so that a continuous record of each may be secured. Different size cores require a different drying temperature and a longer time interval. With records available, it can soon be ascertained what time and temperature will be needed for the average sizes of cores the shop will be required to handle.

The equipment would consist of a recording instrument of the circular-chart type, clock driven, actuated by a bulb containing a nitrogen gas. Bronze or steel armored tubing is used to connect the bulb with the instrument, which if advisable may be located 150 feet away. The temperature limits for core drying lie between 300 and 600 degrees Fahr. so that a chart range 50-600 degree Fahr. or 50-800 degrees Fahr. will answer every requirement. The bulbs are usually suspended through the tops of the ovens and kept in position by either a flange or metal strapping. The armored flexible tubing should not be extended into the oven when the temperature exceeds 200 or 300 degrees Fahr. Under conditions necessitating the installation of the flexible armored tubing part way through the oven, solid copper or steel tubing should be used.

Automatic Control

Another efficient form of temperature measuring equipment is a central-station indicating electric pyrometer. A thermocouple of special sensitive construction is installed in each oven and connected by wiring to the central-station switch. One or more recording pyrometers may also be connected through a plug-type switch, each plug representing an oven. In this way records may be made of any equal number of ovens. Burned cores as well as green cores may be avoided by proper temperature regulation of the ovens.

Automatic temperature control is being applied on nearly all heat-treating processes. An automatic control combined with an advancing time and temperature schedule mechanism will place furnace operations in the future on a more nearly automatic basis.

Presents Sand Mixer

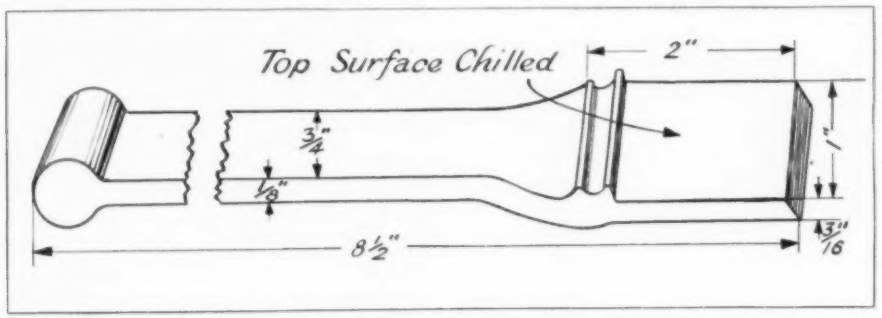
H. S. Simpson, president of the National Engineering Co., Chicago, has presented to the University of Illinois, Urbana, Ill., a complete sand mixing unit to be installed in the foundry instructional shop. This mixer will be used in the daily work connected with the operation of the foundry and also will be of value in experimental work contemplated on reclaiming and forming synthetic molding sands.

Correcting Flaws in Metals and Mixes

Problems of the Gray-Iron, Malleable and Steel Foundry Discussed
By H. E. Diller

Iron Wavy Against Chill

Question—We are endeavoring to make the small gray-iron casting shown in the accompanying illustration; the rectangular end is chilled on one surface. We are using cast-iron chills about 1½ inches thick. It is essential that the chilled surface be absolutely smooth as it is used for shaping glass in a plastic state. Occasionally we obtain a surface fairly smooth but frequently the surface contains waves or an egg-shaped cold shut appearance. We have tried coating the surface of the polished chill with heavy oil, light oil, graphite, oil and lamp black, soapstone, chalk, shellac and uncoated. We have gated over the chilled portion as well as along side of it, and have run the metal across the chill. We have reduced the thickness of the chills used to ⅜ inch but only are able to produce one perfect casting in five or six. We will appreciate any suggestions you may make.



TO PREVENT WAVES THE METAL SHOULD BE POURED QUITE HOT

Answer—We understand from your statement that you place the chill in the cope of the mold and cast the metal against this flat surface which is turned down. We should prefer to have the chill on the side of the mold. We should gate the casting about an inch from the shoulder and if necessary put a riser on the end opposite the chill. The chill should not be made any thinner, but might be increased to 2 inches in thickness. Should you desire to continue casting the metal as you are now doing, an increase in the height of the gate, to give you more pressure on the metal would be advisable. You do not give us the analysis of the metal which might influence the result to some extent, but we believe by following our first recommendation, that you will overcome your difficulty.

Of course, primarily the wavy structure is due to the metal being poured too cold. It is essential to have hot metal to secure a smooth surface against the chill.

Cracks Appear in Pistons

Question—We are sending you a sample piston which has a small crack at the edge of the mouth. Similar cracks develop in our pistons on machining and we would like to know how to avoid them.

Answer—We have examined this piston and find that the edge is rather hard due to the thin section together with the quality of the metal, which is evidently low silicon. This would have a tendency to cause cooling strains and make the casting crack where it does. Another thing which might cause the cracking would be a core which was too hard to give as the casting shrinks. To remedy it, you should have a more friable core. A slightly thicker flange on the end would also help somewhat.

Core Sand Cleaned from Small Cavities

Question—We made several cast-iron vacuum-pump bases which have two ⅜-inch cores. The only entrances to the cavities formed by these cores are two holes in the upper part of the pump base and even these are not through a direct channel. In trying to remove the sand the castings were dipped in acid, but this made the condition worse instead of better and now the sand is caked in a manner which seems to defy cleaning. Please advise us how to dissolve out the sand.

Answer—Not knowing the exact condition the sand is in we cannot tell you definitely what to do. The action of hot concentrated nitric acid would disintegrate the binder, but it would be necessary to put the acid into the casting, heat it and let it work for a while, then wash out thoroughly with hot water and continue this operation several times. You might succeed better by using warm hydrofluoric acid diluted with four times its volume of water. The casting could be left in this a long while as the acid will not dissolve the iron. After the action of the acid is finished the casting should be washed out with hot water and left in the hot water solution for some time to allow the water to dissolve the silicon fluoride formed by the sand and the acid. Agitation both while the acid is in the casting and while the casting is in the hot water would be of assistance in aiding solution.

Mixture for Cylinders

Question: Please tell us what mixture to use to make marine engine cylinders, with a wall thickness of 1½ inches; also what should be the composition of the iron? Would boiler plate and pig iron be a better mixture than car wheels and pig iron?

Answer: Such a mixture should be composed of approximately 50 per cent pig iron, 40 per cent gray iron scrap and 10 to 15 per cent steel scrap. This mixture should be of such composition that the metal from the cupola will contain 1.25 to 1.50 per cent silicon, approximately 0.5 per cent phosphorus, and 0.6 per cent manganese. The sulphur should be kept below 0.120 per cent. A closer grained, softer metal can be secured by adding four to six pounds of pea-size ferromanganese per ton of metal. This should be added in the ladle as the metal flows from the cupola.

Boiler plate punchings added to the mixture will strengthen it more than car wheels will. This is due to the fact that steel additions to the mixture make a finer grained iron. If enough steel is added, say 20 per cent or more, the amount of total carbon in the mixture will also be somewhat reduced. The amount of carbon is not reduced as

greatly as it would be thought by figuring the percentage of carbon in the charge, as the steel absorbs carbon from the coke with which it comes in contact during the melting process.

Small Cupola Practical

Question—Please tell me the dimensions of the smallest cupola you consider practical for a foundry, and state whether the cupola would melt good hot iron.

Anwer—The smallest sized cupola which is generally considered practical has a shell of 27 inches and is lined to 18 inches inside diameter. It should have a height of approximately 12 feet from the bottom to the charging door but would give service if this height was 2 or 3 feet less. Such a cupola will melt ¼ to ½ tons per hour. The tuyeres of a cupola are usually 1/9 the greatest sectional area of the melting zone. It would pay you to order a cupola from one of the firms supplying cupolas instead of trying to build it yourself. This policy has been found to be the best as the manufacturers have had long experience in designing cupolas and are able to build them to secure the utmost economy.

There is no reason why hot metal cannot be secured from the 18-inch cupola which we have described. However, the pig iron should be broken into pieces not longer than 10 or 12 inches before being charged.

Melting Methods Cause Small Gas Holes

Question: We have been manufacturing synthetic pig iron in our electrical furnace for some time, and have recently furnished a foundry with 100 tons of a trial order, to be used by them in the manufacture of standard cast iron water pipe.

The first two carloads were of the following average analysis:

Silicon	2.77	3.03
Sulphur	0.024	0.040
Phosphorus	0.28	0.26
Manganese	0.41	0.51
Carbon	3.56	3.31

The firm had other irons which were of about the same composition and the following mixture was used:

	Pounds
Eastern pig	200
Synthetic pig	300
Car wheels	550
Brake shoes	150

The pipe made from this iron was porous at the bottom. On analysis it showed:

Silicon	1.43
Sulphur	0.11
Phosphorus	0.39
Manganese	0.26

The only reason that we are able to advance for the porosity is that this particular cast was made on Monday, and the molds had been dried on Saturday night instead of Sunday night, therefore, were cold instead of warm as was usually the case.

Answer: The trouble is not due to the mold, as you suggest might be possible, but is due to the fact that the iron contains a high percentage of sulphur with a low percentage of manganese. It would look, too, that the iron had been oxidized in melting as indicated by the excessive loss in manganese. Both of these conditions would have a tendency to cause the iron to give off gas on setting and as this gas is given off after the outside of the metal had been set, gas holes are formed in the center of the casting.

To neutralize the high percentage of sulphur in the metal, spiegeleisen should be added to the charge in the cupola to bring the manganese content to between 0.60 and 0.90 per cent. Oxidation would be caused either by not having enough coke on your bed or between your charges, or both. It might also be caused by having too high pressure on your blast.

Iron for Cylinder Liners

Question—Kindly advise us the mixture and composition of the gray iron for a marine cylinder liner 28 inches in diameter with walls 1 inch thick.

Answer—For marine cylinder liners 28-inch diameter and 1-inch in thickness of wall you should use a mixture composed of 15 per cent steel scrap charged on the coke, then an addition of 35 to 50 per cent gray iron scrap covered with pig iron to equal 100 per cent. The scrap and pig iron should be of such composition that the metal coming from the cupola will contain; silicon 1.25 to 1.50 per cent; sulphur, less than 0.12 per cent; phosphorus between 0.2 and 0.4 per cent, and manganese between 0.6 and 0.9 per cent.

Composition Causes Rim in Malleable Iron

Question: I am sending you a sample of malleable iron which shows a heavy rim on the outer edge, as I would like to know what caused this rim. The analysis of the casting is:

	Per cent
Silicon	0.79
Sulphur	0.07
Phosphorus	0.146
Manganese	0.33
Total carbon	2.26

Answer: The rim on your casting is what is known as a *composition rim* and is caused by abnormal chemical composition. The main trouble is with carbon which shows low by the analysis. However, some of the castings may have even less carbon as you probably are burning out carbon while the heat is being poured and if this is the case you should use less blast and possibly more fuel after you start to pour the heat in order to secure a reducing instead of an oxidizing atmosphere. You could determine whether you are burning carbon out of the iron during pouring by taking a sample of the first iron tapped and again just before the last iron comes from the furnace. In addition to the carbon being low, the manganese is a little high. It should run from 0.20 to 0.30 per cent. Sulphur also borders on the high side.

Urges Uniform Costs for National Founders

Installation of uniform cost systems in various branches of foundry industry was urged by Robert E. Belt, secretary-treasurer of the American Malleable Castings association, at the closing session of the twenty-fifth annual convention of the National Founders' association at the Hotel Astor, New York, Nov. 18. This is a duty, he said, that foundrymen not only owe to themselves, but their competitors.

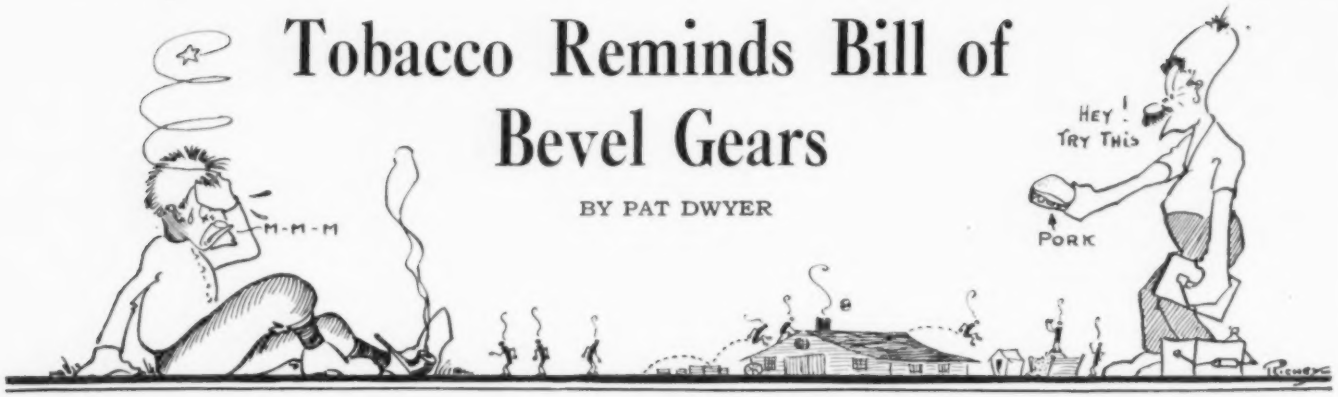
L. A. Hartley, of the Nebraska state department of vocational education, outlined a system for training foundry foremen, which within the past year or two is said to have met with success in Nebraska.

Resolutions were adopted at this session urging the appointment of a public tribunal to adjust railway labor questions and to prevent interruption of service. The executive officers of the association for the coming year are: President, William H. Barr, Lumen Bearing Co., Buffalo; commissioner, A. E. McClintock, Chicago; secretary, J. M. Taylor, 29 South La Salle street, Chicago, and treasurer, Chicago Trust Co., Chicago; and M. Griswold Jr., General Electric Co., Erie, who succeeds Julius Goslin, Joubert & Goslin Machine & Foundry Co., Birmingham, as vice president.

Installation of an electric furnace being completed by the Williamson-Harris Machine Co., as a new addition to the company's foundry at Cordele, Ga. The company will start the manufacture of steel castings as soon as the furnace has been completed. The company manufactures stump pullers and wheel presses.

Tobacco Reminds Bill of Bevel Gears

BY PAT DWYER



STARTING at the comparatively tender age of 13 with pieces of rattan cane and gradually progressing further in the ways of iniquity through ferns, tea and mullin leaves to sweet caporal cigarets and various brands of light tobacco, I was ready when I entered the foundry at 16 to try a few puffs of a brand of twist tobacco greatly affected by the molders in that part of the country. It was made by a famous philanthropist in the city of Montreal and at the time I became acquainted with it and for several years afterward, retailed for the modest sum of four cents. A portion, about 5 inches in length and ¾-inch in cross section, for some reason never satisfactorily explained, was known as a fig and was esteemed equally for smoking and chewing.

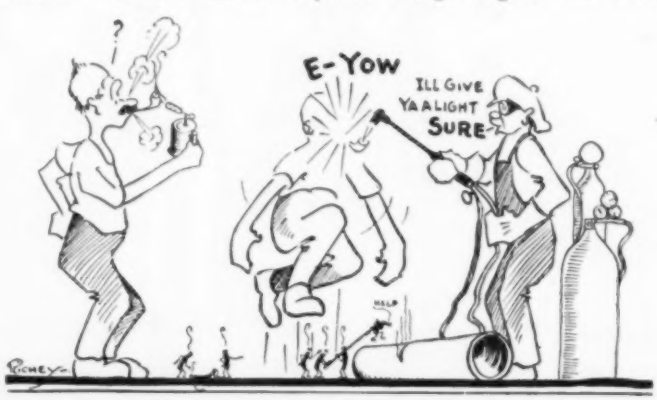
The gentlemen who chewed, kept the tobacco in the right hand hip pocket in company with a towel and a double ender and before indulging in a chew, either wiped or blew the dust and sand off the bitten end.

It was reported currently in this shop that one of the men with a reputation for thrift if not of actual stinginess was in the habit of investing 50 cents in this commodity every fortnightly pay night. The alleged reason being, forsooth, because while the retail price remained at four cents a fig he could secure 13 figs by plunging to the extent of 50 cents a throw. As a further example of his thrifty and methodical habits, it was stated that he limited himself to half a fig on each of the two Sundays so that the 13 figs would cover the 14 days. He also was a firm believer in and exponent of the sentiment expressed by the ant when that well known personification of all the virtues, with the exception of Charity, was asked for a hand out by his long-legged, happy-go-lucky and improvident grasshopper first cousin. You probably remember the touching little story in the old school reader which relates how the champion long distance jumper danced and sang all summer long, but neglected to lay up any provender for the long and cruel winter. When the wintry wind—wind, of course, in this instance rhyming with blind—well, anyway as I was saying, when the wintry wind began to blow through the holes in his clothes and his source of food supply was cut off, he approached his pot-bellied, smug little friend and with cap in hand, trembling knees and an icicle hanging to the end of his little nose, humbly begged for the loan of a little food. Our dear little friend with a shrug of his shoulders and with palms out spread turned him down cold by remarking blandly, "We ants never borrow, we ants never lend." The opinion appeared to be unanimous in the shop that if our hero had not been an ant in a former incarnation, there was no reasonable doubt that if he ever appeared again upon earth it would be in the shape of one of those interesting little insects.

Needless to say, on a modest stipend or honorarium of 31.9 cents a day I was in no position to squander 50 cents a fortnight on any one luxury. Indeed my total allowance from the family exchequer only comprised that amount and it required a high degree of financial acumen to spread that amount over the period extending from one pay day to another. Fortunately the tobacco was of such a potent and paralyzing character that one fig was all I could manage in a week and I was free to dissipate the remaining 42 cents in an orgy of wild amusement. Fifty cents in these far away halcyon days of our youth was fifty cents and sounded like real money. Not like this modern stuff which only seems to know two words, *good bye.*

Patience, perseverance and a spirit that never says die,—although I will confess that I felt perilously near the jumping-off place on several occasions,—sustained me during the four years of probation and finally when I qualified as a journeyman molder not the least of my accomplishments was the ability to smoke as much of this tobacco as the star molder. It was not until several years later and after a certain young lady had elected to journey hand-in-hand with me down this vale of tears that I learned what a mistake I had made. She has declared that the smell is just a little worse than that of a smoldering garbage heap in the back yard of a glue factory and has hinted occasionally that if she ever has occasion to sue for a divorce, all she will have to do will be to allow any judge in the land to get one whiff of that tobacco to secure an absolute decree, custody of the children, alimony and everything.

A clay pipe full of this tobacco will burn steadily for nearly an hour, but I practically had finished serving my time before I became sufficiently case-hardened to finish a pipe full at one sitting. In my early experience a pipe full, smoked intermittently, would last all day. Heavily saturated with molasses to meet the dainty and highly cultivated taste of the chewing fraternity, the



THE WELDING MAN CAN DO ALMOST ANYTHING

(*Continued from Data Sheet No. 406*)

Notes and Precautions—Very rapid solution may result in some loss of sulphur.

$KClO_3$ has proved a much more satisfactory reagent than Na_2CO_3. It has the added advantage of being a strong oxidizing agent and we have had no trouble from separation of free sulphur in high-sulphur irons. When using $KClO_3$ the graphite is often almost completely oxidized.

It is not advisable to bake the iron and potassium salts for more than a few minutes. Nothing is gained and sulphur may be lost. Also redissolving is made more difficult.

Titanium (if present) sometimes separates upon dilution. It must be filtered off.

The precipitation by $BaCl_2$ should be carried out carefully. (See standard text books such as Treadwell and Hall, Scott, Blair, Lord and Demorest, etc. for more complete methods.) By proper manipulation a granular precipitate can be obtained which will separate almost completely within three hours. For accurate work longer precipitation time is necessary.

The filtrate must be examined for traces of BaSO which have passed through the paper. The fact that the $BaSO_4$ is slightly soluble in HCl wash and hot water is more than compensated by the speed and completeness in freeing the precipitate from iron.

With proper precautions this is the most accurate method for sulphur in irons and steel. As extremely small quantities are involved work must be very careful. A blank should be run and deducted from the final weight of $BaSO_4$. Purification of a contaminated $BaSO_4$ precipitate is rather difficult and there is nothing particularly hard in obtaining a pure precipitate. If precipitate is tinted brown fuse with 1 gram Na_2CO_3, leach out in hot water, filter, wash, make slightly acid with HCl and precipitate with $BaCl_2$.

Limit of allowable error 0.003 per cent plus or minus on an 0.08 per cent sulphur sample.

Volumetric Method for Sulphur

Solutions

Hydrochloric Acid—Five hundred c.c. conc. HCl plus 500 c.c. H_2O.

Cadmium Chloride—Six to 8 grams $CdCl_2$ plus 350 c.c. conc. NH_4OH plus 650 c.c. H_2O.

Iodine—One gram resublimed iodine plus 10 grams KI is dissolved in a small amount of water, then diluted to 1 liter.

Starch Indicator—Two or three grams soluble starch dissolved in about 100 c.c. hot water.

(*Continued on Data Sheet No. 408*)

(*Continued from Data Sheet No. 407*)

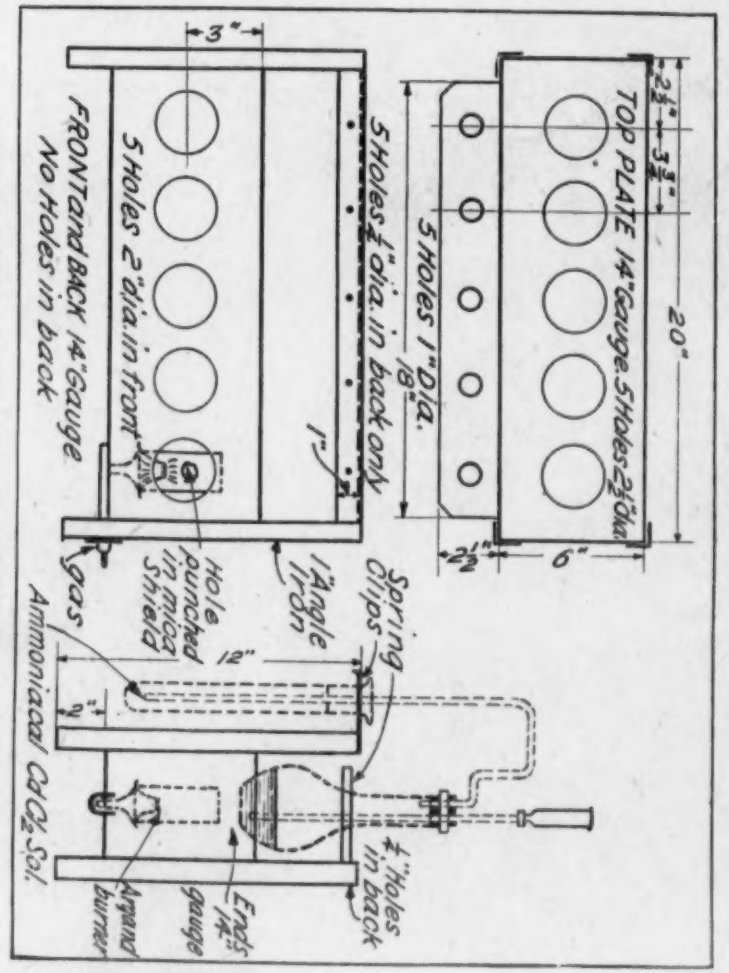


FIG. 4—DIMENSIONS OF THE RACK USED IN VOLUMETRIC METHOD FOR SULPHUR DETERMINATION

(*Continued on Data Sheet No. 409*)

THE FOUNDRY DATA SHEET, DECEMBER 1, 1921

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

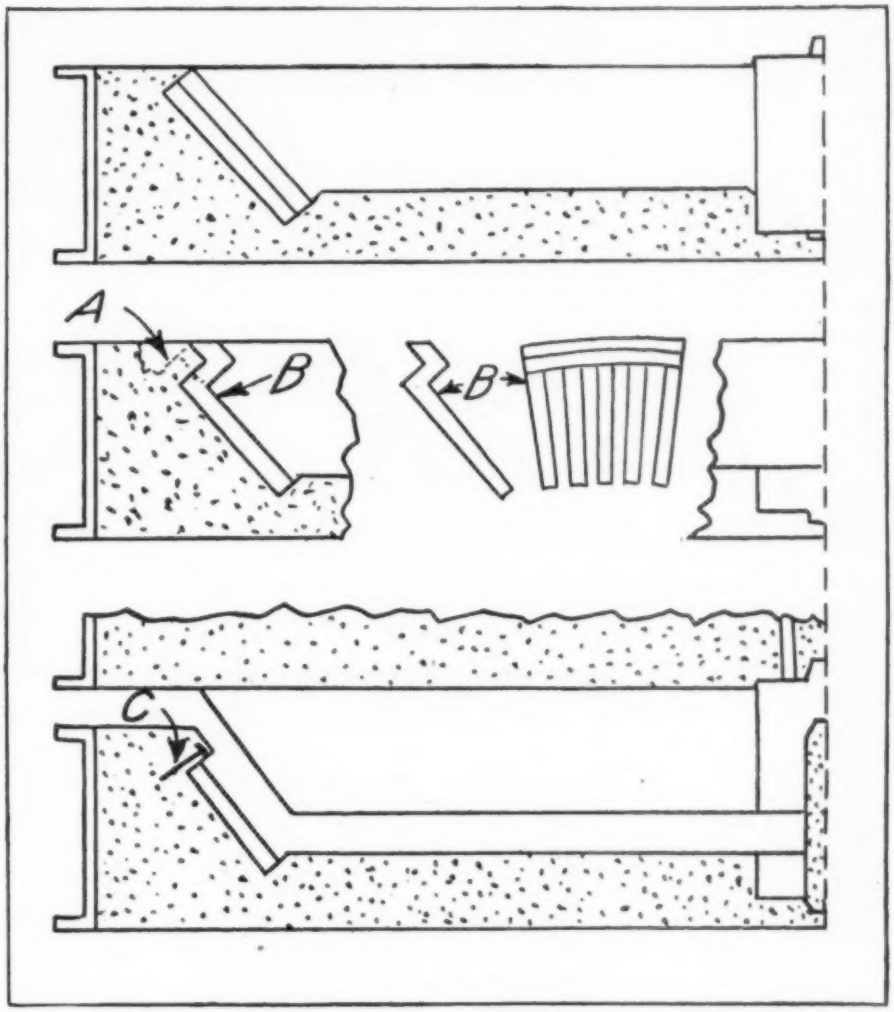
Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

first charge of tobacco was almost impossible to light. While in the shop the flame from a kerosene torch usually was applied. This probably accounted for the popularity of clay pipes. The bowl of a corn cob or wooden pipe was not of a sufficiently refractory character to stand up to that kind of service for any length of time and deterioration of plant and equipment represented too high a factor on capital investment.

Experienced smokers learned to leave a small portion of charred tobacco in the bottom of the pipe and used it as a priming in starting the following pipe full. In this manner it was possible to fire up with a minimum number of sulphur matches which in those days were sold in the form of flat strips resembling combs. When lighted they smelled like the ruins of Sodom and Gomorrah. The cupola tender scorned the use either of torch or matches. During the progress of the heat he lighted his pipe by the simple expedient of inverting the bowl over the incandescent end of his tapping bar and on other occasions he achieved the same result by heating a short rod either in one of the salamanders in winter or in the core oven fire in the summer.

For several years George V of England has had to worry along without my aid or assistance as a contributing member, but as a compensating measure I have been unable during that time to secure any of the tobacco manufactured, as the legend states, under the august protection of his crown and dignity. On a recent occasion I happened to visit one of the border towns and naturally went for a short trip into the territory on the other side of the international boundary line. I did not go far, just as far as the first tobacco store. To my anxious inquiry the young man behind the counter assured me that the old reliable still was on sale, how much did I want? I found that the price had advanced 375 per cent over the old 4-cent rate, but with that reckless disregard for money which characterizes your true tourist I laid down a dollar bill and walked away with seven short pieces of material that looked like petrified tar rope, but which smelled like real tobacco.

Immediately on my return and with the laudable intention of sharing the good word I called upon Bill and prevailed upon him to accept half of the manna in the wilderness. If there is one of the five senses more than another bound up with that peculiar part of a man's make up known as memory, it is the sense of smell



ABOVE—BEFORE MAKING THE PARTING CENTER—METHOD OF APPLYING STOP-OFF PIECE BELOW—THE MOLD READY TO CLOSE

and as the smoke from our pipes curled and floated upward and filled the air with fragrance it only was natural that our minds should turn back to other times and other places. Among other things we compared notes on the many varieties of tobacco we had tried, in a vain endeavor to find something that would take the place of the one and only and I ventured the opinion that a man is after all a pretty adaptable kind of a creature, if he can't get what he wants he will do the best he can with a substitute of some character.

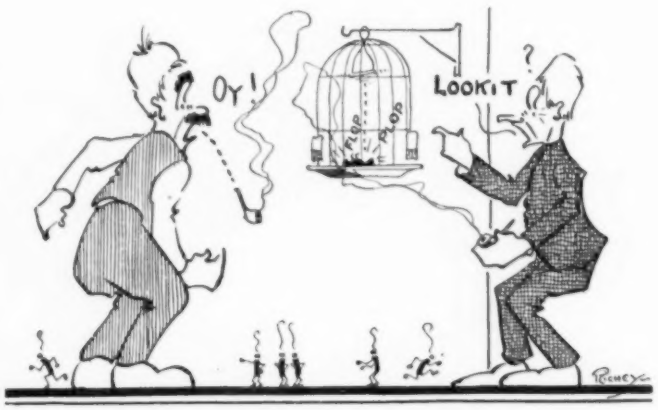
"When it comes to adaptability" said Bill, "I think the molder has them all backed off the end of the dock. I don't mean the man in the specialty or mass production shops. He has troubles of his own, but usually these troubles arise from other causes than lack of accurate rigging. He has follow boards, match plates, accurate flasks and patterns and gages and jigs to set his cores. Consider the man in the ordinary jobbing foundry, he not only has to adapt existing flasks to a variety of shapes and sizes, but frequently he is called upon to adapt a pattern to a use for which it never was intended.

"You probably have noticed that no two designers ever were in harmony over the design of any given piece of machinery and each one usually has some pet notions in regard to gear wheels. You can go into any of the jobbing foundries, some of them dating back 50 years and find patternmakers working on gear wheels, notwithstanding the fact that gear patterns have been made steadily since the plant was organized and the pattern storage is jammed from the basement to the roof. Yet orders are received every day for gears a little different from any pattern on hand.

"For its size, probably a gear wheel pattern is the most expensive of any to construct and this added to the fact that it requires considerable time influences the foundryman to try and adapt an existing pattern resembling the required casting in some particulars. For instance if the number and pitch of the teeth are correct he can change the shape and size of either the arms, hub or center core, or all three. Increasing or decreas-

ing the face of a spur wheel is practiced to a considerable extent according to methods which I have pointed out on several occasions recently, methods which present several points of interest; but when it becomes necessary or desirable to treat a bevel wheel in the same manner another factor is added to the problem. The face on a bevel gear can be reduced in two ways by the molder. First by cutting off the ends of the sand teeth in the drag and adding a corresponding amount of sand to the cope and second by cutting the ends off the sand teeth and then building the necessary stopping-off ring of sand in the drag. Some time ago we had one of these wheels to make and a few words on the process adopted will illustrate the method in a general manner. Minor adjustments may be required in the case of certain bevels, but the following method substantially can be applied to any bevel gear wheel. The customer ordered two bevel gear wheels 6 feet in diameter and alike in all particulars with the single exception that the teeth on one were to be 9 inches long and only 7 inches long on the other. We had a pattern made for the wider wheel and made one casting off it and then made a mold for the second casting, the one with the 7-inch teeth.

"The drag was rammed and rolled over in the usual way and a parting made down to the bottom edge of the rim on the inside, after which the arms and hub were placed in position. The usual V-shaped parting on the outside end of the teeth was not made; instead, the sand was slicked off in a straight line as shown above in the illustration on page 943. Parting sand was sprinkled over the joint and then the cope was set on, soldiered, rammed and lifted off. It was turned over and lowered onto two blocks where it was finished by nailing the sand along the sides of the arms and around the hub. The pattern then was drawn out of the cope and the mold finished and blacked.



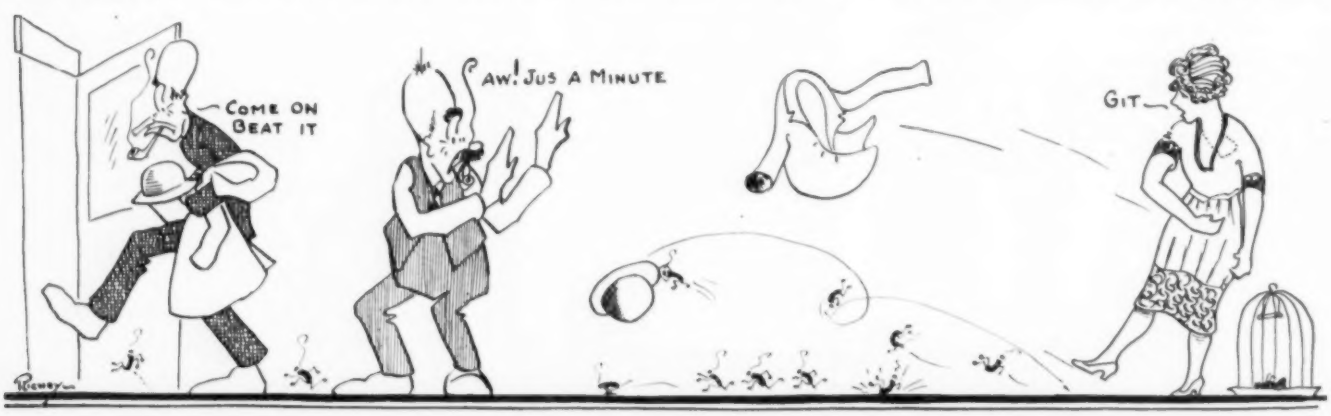
THESE OPEN-WORK CAGES ARE NOT SAFE

"While the mold was in process of construction the pattern shop had prepared a making-up piece which is shown in the center of the illustration. As will be noted, it was made up of five teeth, exact counterparts of the teeth on the wheel except that they were 2 inches shorter. They were set to the same pitch as those on the pattern and were held together across one end by a shoulder or band which served as a guide in stopping-off the ends of the teeth and also left a shoulder which coincided with the cope face when the mold was closed.

Applying Make-up Piece

"Before drawing the pattern out of the drag, the sand was cut away from the top edge on the outside until the ends of the teeth were completely exposed. No attempt was made to observe any symmetry during this operation the sand just was dug out with the trowel until it was seen that there was sufficient clearance for drawing the pattern. After the pattern was drawn and put away the making-up piece already referred to was taken and carefully set into the teeth. The teeth on the making-up piece were 2 inches shorter than the teeth on the gear pattern and therefore by making the mold up to them or in other words, by cutting off the ends of the sand teeth the teeth on the resulting casting would also be 2 inches shorter than the teeth on the pattern. The making-up piece is shown in position in the middle drawing. Facing sand was packed in the gap left around the top rim which was made for clearing the teeth of the pattern, and also in under the shoulder of the making-up piece. The sand was slicked off flush with the original joint after which the making-up piece was drawn out at an angle and set in again five teeth further along. The process was repeated until all the teeth had been served in a like manner. A row of nails, one of which is shown at *C* was set around the rim to carry the overhang.

"The cope was not dried, but the drag received a skin drying, after which the center core was set and the cope turned over and set on. The mold is shown nearly closed in the bottom drawing. It will be noted that the shoulder left by the making-up piece will come into contact with the bevel face of the cope and stop off the thickness of the rim at the point where the teeth terminate. Closing the mold, clamping, making up the runner and riser, pouring, stripping the hub and digging out the center core all followed as a matter of routine and presented no unusual features or anything beyond regular practice."



WHERE THERE IS SO MUCH SMOKE SOME ONE IS BOUND TO GET FIRED—AESOP, HIS FABLES

"Now, on the other hand" Bill continued "the foundry man occasionally is confronted with the problem of making a wide-face, bevel, gear wheel from a narrow-face pattern. In an instance of that kind, the mode of procedure is slightly different from the foregoing. He extends the rim of the wheel pattern before ramming the cope and in that manner only has to extend the teeth after the pattern is removed. I'll make you a sketch of a wheel partly molded and you can see the idea more distinctly."

Before he had any opporunity of elaborating on the theme Mrs. Bill appeared in the door way. She held her handkerchief to her nose with one hand and with the other pointed to the door leading to the street. I trust I am no more superstitious and place no more faith in signs and omens than the average man, but I have learned to add 2 and 1, skip the other 1 and make 4 so when I saw Bill silently oozing into the outer darkness I lost no time following him.

How and Why in Brass Founding

By Charles Vickers

Bronze Disk Castings Crack from Stems

We have experienced considerable trouble when making bronze valve disks, a casting consisting of two valve disks superimposed, and connected together by a stem, nine sixteenth diameter, round, and two inches long. As the disks have guides cast on, they resemble two stools connected together by the stem aforesaid, making a three-part molding job. The difficulty is caused by the stems cracking at their junction with the disks; the cracks being sometimes at the underside of the upper disk and again where connected to the tops of the lower disk. When this cracking occurs the disks break apart, and the casting is ruined. We are using the following alloy: Copper, 86 per cent; tin, 10 per cent; zinc, 2 per cent, lead, 2 per cent. The bronze is melted in a pit-type furnace using anthracite coal. Virgin metals are used and are carefully melted under a covering of charcoal. Sometimes after pouring, the castings are allowed to remain in the molds until cool, and at other times they are shaken out within five minutes and are plunged into cold water to blow away the sand and make them clean.

The castings are molded six on a gate, in a three part flask no cores being used. Your suggestions as to the cause of this difficulty will be appreciated.

In order to be able to withdraw these patterns, one disk must be loose. The gate marks on the sample casting indicate the loose disk is the bottom disk in the mold when cast, which means the disks, both of them, are cast with the prongs or guides downward. This would be the natural way to mold the castings. The loose disks would be laid prongs up, on a match or follow board and the drag would be rammed and rolled. the upper disks with attached stems would be fitted in place on the loose disks and the cheek being placed over would be rammed. The cope would be rammed and lifted off, the upper disks with stems drawn, then the cheek would be lifted and the loose disks in the drag would be removed. The mold would then be finished, the cheek and cope being closed in their respective turns.

When we stand a casting on its guides like a stool on any flat surface, we note that the prongs on both upper and lower disk are below the point of junction of the stem to the body of the disk. Also these prongs are comparatively heavy. As liquids seek their lowest level, the metal in solidifying will feed down into the prongs, because they are lowest, and it is conceivable that in so doing there is a slight drainage from the parts of the stem still liquid, which would be at the connection of the disk top and bottom. This would produce a hair crack, and whether this occurs at the top or bottom disk, or on both would depend upon many things, such as the temperature of pouring etc.

If this hypothesis is correct, then the difficulty would disappear if the molds were rolled over before being poured. Also, the part that is now the cope, which would then become the drag, should be rammed harder than the other parts of the mold. This would hold the bottom disk from sinking by its weight into the mold and thus tending to produce a crack at the junction.

We can see no objection to thus rolling the finished mold; all that is required is to cut the sprue through what is now the drag. A careful molder can do this and have no dirt get into the molds. Another point to be careful about is to wipe away the fin of molding sand that forms at the junction of stem and loose disk. That produces a ridge clearly visible on the sample castings, and if there is any tendency to crack this is where it will occur.

Ingot Bronze Recommended for Long Bushings

We are making bushings, 8 inches in diameter and 21 inches long, weighing about 250 pounds. The metal after being turned off appears filled with dross. We enclose a sample for your inspection. Can you tell us what causes this trouble?

As far as can be determined from simply looking at the sample, the alloy has been badly oxidized while being melted. Also it appears that the alloy contains either aluminum or silicon. The latter would be more likely to cause the holes than would aluminum, especially if lead were present. An analysis would throw light on the difficulty and we suggest that one be made.

In the meantime it would be advisable to use new metals in making the alloys for these castings. If supposedly new metals have been entirely used, there is something wrong with them. This can be determined by a complete analysis, of the copper, tin, lead and zinc, used to make the alloy. In place of using scrap metals, or new metals of doubtful ancestry, it would be better to obtain the ingot bronze made to the specifications of the alloy expected in these castings. Good reliable ingot bronze can be obtained at a material saving over the cost of all new metals, which when melted with a little care will produce good, sound castings.

Temperature Controlling Factor in 88-10-2

We are making castings of 88-10-2 and experience difficulty getting them steam and water tight. After the metal is machined it appears perfectly clean, but under steam or water pressure the castings leak, sometimes in spots, at other times over the entire surface. We melt the copper first under a cover of charcoal and glass, then add the tin

and zinc. We also have tried making a hardener containing 40 pounds copper, 10 pounds tin, 2 pounds zinc, cast into sand molded ingots then remelted with 48 pounds additional copper.

Study first the pouring temperatures. If a pyrometer is available pour the metal at 2200 degrees Fahr. Poured at 2000 degrees Fahr., the castings will be unsound and will leak and poured at 2550 degrees Fahr., they will be spongy. This means that the alloy should be poured at a bright orange, known in foundry terms as a *medium temperature*. Second, change the mixture slightly. Instead of adding the zinc in metallic form, make the following alloy:

Copper	48 pounds
30 per cent manganese copper	2 pounds
Zinc	50 pounds

Pour into small ingots.

Melt 84 pounds of copper under a covering of charcoal; use a deepener on the crucible to hold all the copper charged cold. When melted add 2 pounds of an alloy 50 per cent copper, 50 per cent nickel, stir, add 4 pounds of the copper-zinc alloy, stir, add 10 pounds of tin. If the castings still leak ingot the first melt of completed alloy and remelt the ingots and place 1½ ounces of phosphor copper per hundred pounds of alloy in the bottom of the crucible when charging.

Aluminum Alloy Leaks Under Pressure

We are manufacturing an aluminum box 12 inches long, 6 inches wide and 7 inches deep. This box must hold an air pressure of 100 pounds without leaking; the walls are ⅞ of an inch thick and some of the boxes leak a little. We would like to know what to add to close the pores and make tight castings.

A more intelligent reply could be given if the composition of the alloy now being used had been stated. Assuming that it is a No. 12, containing 8 per cent copper the thing to add to close the pores is more copper.

Instead of 8 use 12 per cent copper, and if the metal becomes too brittle for such a casting, reduce the copper from 12 per cent, to a point where the leaks will stop and the metal will have the necessary strength.

Thinnest Allowable Sections in Aluminum

We are contemplating the use of aluminum in rectangular castings. In designing these castings we want to use a metal as thin as possible, but we have no definite information in the matter, and we desire you to inform us how thin the section of metal may be and still give satisfactory castings free from porosity.

The minimum section of metal should be 5/32-inch in thickness. This will allow the aluminum to be poured at a temperature that will produce sound castings. A thickness of ⅛-inch would require the pouring temperature to be too high for a maximum yield of sound castings.

Cause of Porous Aluminum

We are casting flat aluminum covers, using No. 12 alloy, and have experienced some difficulty from pitting and porosity and we would appreciate any advice you can give us as to the cause of our difficulty. The castings are about 2 feet in diameter flat and about ¼ inch in thickness. At what temperature would you recommend pouring this metal? Will it be necessary to use a pyrometer?

The pitting is caused by thick and oxidized aluminum running into the molds. The surface layer of molten aluminum is always more or less viscid from contact with the atmosphere, and if this is permitted to get into the casting it produces the localized and irregularly-shaped holes complained of in the present case. The metal is viscid because oxide is entangled with it. A separation of the oxide and metal may be effected by the addition of zinc chloride as a flux on the aluminum just before it is removed from the furnace. Use the fused zinc chloride, and add a piece the size of a hickory nut to each melt, in a large kettle a little more will be required. Simply stir the chloride into the aluminum when a reaction will occur that will liberate a large amount of dross. It would also be advisable to use a number of gates instead of the two shown on the sketch, in order to spread the flow of the metal over a greater area of the mold. A pyrometer is useful for getting the correct temperature of aluminum alloys. These castings will require to be poured around 1300 degrees, Fahr.

Metal for Print Shops

Will you kindly advise if there are any special conditions which govern the manufacture of linotype and stereotype metal, other than those which would be employed in alloying any babbitt metals? We would also like to get the composition of such alloys.

As far as the alloy is concerned it is handled exactly the same as babbitt metal, especially the anti-friction metals having a lead base, which will approximate type metals in composition. It would be advisable to get the regular printing metal ingots, as they usually differ from the ordinary babbitt ingot. The following formulas are supposed to be standard:

Electrotype Metal	Per cent	Linotype Metal	Per cent
Lead	93.00	Lead	83.00
Antimony	4.00	Antimony	12.00
Tin	3.00	Tin	5.00

Monotype Metal	Per cent	Stereotype Metal	Per cent
Lead	74.00	Lead	82.50
Antimony	18.00	Tin	4.50
Tin	8.00	Antimony	13.00

The formula of stereotype metal is the one used generally for purposes where several alloys formerly were used. In many cities there is a remelting clearing house for type metals. the used type, collected from the printers, is remelted into ingots and again issued to the concerns which make a specialty of casting the type for the printers. After being re-melted a few times the formula gets around 3.5 per cent tin, 11 per cent antimony, and the remainder lead. This is cheaper.

Condensation of Moisture

Will you kindly advise the best way of treating a steel insert cast into aluminum. A solid piece of steel about ⅜-inch diameter is capped with an aluminum bottom to form an accelerator pedal. The thickness of aluminum is only ⅛-inch. We were thinking of coating the steel with crude oil, but you might be able to suggest a better way.

The interior of the mold is filled with air saturated with water vapor and since the steel is colder than the air the moisture condenses on it causing the casting to blow. To prevent this condensation and consequent blowing the piece of steel must be warmer than the air in the mold. If it is hot when the metal envelopes it, then it will be dry and there can be no blowing. It follows therefore, that to get the maximum of good castings the molds should be cored with the steel inserts just before they are poured. The steel inserts also must be free from rust and be perfectly clean. The use of oil will help provided it is desired to pour the molds with the inserts cold. Water will not condense on an oil covered surface as readily as on a clean metal surface. It the insert is colder than the sand a loss due to blown castings will have to be taken no matter what kind of a coating is used. This loss will be increased as the day advances and the sand grows warmer. It will help matters materially if the inserts are oiled kept as warm as possible up to the moment of insertion in the molds, then the molds poured before they stand any length of time. Condensation of water vapor thus will be kept to a minimum.

Carbon Main Factor in Car Wheels

Ratio of Combined to Graphitic Carbon Must Be Held Within Narrow Limits In Chilled Iron Wheels—Other Elements Act Largely Through Their Influence on Carbon

BY Y. A. DYER

THE ratio of combined carbon to graphite in gray-iron castings is directly the controlling factor in determining hardness, softness, strength, toughness and fluidity of the metal, while certain other elements exert an indirect influence on carbon. The most recent developments in research work connected with the manufacture of cast iron car wheels, as reported by H. J. Force in a paper read at the recent convention of the Society for Testing Materials, and reprinted in THE FOUNDRY, Aug. 1, indicates the importance of carbon in cast iron car wheels.

The cast iron car wheel is a representative specimen of the blending of white, mottled and gray iron in one casting and therefore requires extreme skill in its manufacture; necessitating the exercise of co-ordinated chemical knowledge and mechanical skill to solve the problems involved in molding, cupola practice, mixing of metals, pouring and annealing of wheels.

A number of analyses of wheels which failed are given in Mr. Force's paper. The majority of these failures are reported due to cracked plates and worn flanges. It is not a difficult matter to assign responsibility for the faults mentioned—they may be directly attributed to high combined carbon, but hardly to the small percentage of phosphorus present.

The carbon ratio is clearly the controlling factor in car wheel iron, and whenever the approximate true pearlitic structure in cast iron (0.83 per cent combined carbon) greatly is exceeded it is reasonable to expect an inferior wheel. As a matter of fact, 0.70 per cent combined carbon, which produces a hypoeutectoid matrix, would seem to more nearly represent the ultimate chemical analysis to produce an ideal structural composition of the metal. Reference to following ultimate and proximate chemical analyses and structural composition of the car wheel which Mr. Force reports cast on June 28, 1920, illustrates the point in question:

Ultimate analysis	Per cent
G C	1.91
C C	1.31
Mn	0.52
Si	0.80
S	0.193
P	0.354
Iron	94.913
Total	100.000

Proximate analysis	Per cent
GC	1.91
Fe_3C	19.35
Mn_3C	0.24
FeSi	2.40
MnS	0.52
Fe_3P	2.26
Iron	73.32
Total	100.00

Structurally this iron contains 19.59 per cent cementite, therefore its hypereutectoid matrix contains:

Per cent	
85.67	pearlite.
1.91	graphite.
3.54	iron-phosphide in iron.
0.52	manganous-sulphide
8.36	free cementite, or cementite not contained in pearlite.
100.00	Total.

Cementite being a hard and brittle substance imparts these properties to the matrix of the metal, when mechanically free or separated from the pearlite. Therefore, the 8.36 per cent free cementite will tend to weaken the metal in the plate of the wheel.

An iron which has the same composition as the one just noted except that the combined carbon is 0.70 per cent to conform with a more desirable specification will have quite a different structural composition or matrix as follows:

Ultimate analysis	Per cent
G. C.	2.52
C. C.	0.70
Mn.	0.52
Si.	0.80
S.	0.193
P.	0.354
Iron	94.913
Total	100.000

Proximate analysis	Per cent
G. C.	2.52
Fe_3C.	10.20
Mn_3C	2.24
FeSi.	2.40
Mn.	0.52
Fe_3P	2.26
Iron	81.86
Total	100.00

Structurally this iron contains 10.44 per cent cementite, therefore its hypoeutectoid matrix will contain:

Per cent	
83.52	pearlite.
2.52	graphite.
3.54	iron-phosphide.
0.52	manganous-sulphide.
9.90	ferrite not contained in pearlite.
100.00	Total.

Under these conditions the matrix of the metal will contain a large percentage of pearlite—the strongest and toughest constituent of cast iron—and free ferrite or soft, ductile iron. The matrix of the plate metal will thus be strengthened and toughened instead of being comparatively hard and brittle, as would be the case with conditions creating high combined carbon which produces a hypereutectoid matrix, thereby supplying free cementite. Therefore the strength and toughness of the matrix of a car wheel plate must be looked for in high pearlitic formation and minimum free cementite.

The effect of phosphorus on carbon is negligible, but sulphur has a decided tendency to raise the ratio of combined to graphitic carbon, and the lowering of silicon has the same effect. Manganese has one effect under certain conditions and at other times has the opposite effect. Thus these elements should be made subservient to carbon in a manner to procure the proper carbon ratio. Reference to comparative ultimate and proximate analyses and structural composition of metals has been made in relation to the plate portion of metal. By reason of the tread and half of the flange portion of the wheel metal being a so-called *supercooled* iron its structural composition will be quite different. That portion of the metal will contain 51.20 per cent cementite, therefore the hypereutectoid matrix will contain approximately:

Per cent.	
58.51	pearlite.
0.25	graphite.
0.52	manganous-sulphide.
3.54	iron-phosphide in iron.
37.18	free cementite.
100.00	Total.

The large amount of free cementite is the constituent that produces extreme hardness in the tread portion of metal. It is this cementitic (hard) condition of tread blending into pearlitic (strong and tough) condition of plate metal which produces a matrix combining hardness, strength and toughness in a car wheel. Thus it becomes self-evident that carbon in iron is the pivotal element to be closely watched, and other metallic elements and metalloids should be proportioned in such manner as to effect to best advantage their influence on its ultimate condition. The hypereutectoid matrix of the tread can only be controlled through proper mixture of the metal and rational cupola practice, for after the hot metal runs against the iron chill of the wheel mold

its matrix becomes fixed, whereas the hypoeutectoid matrix of the gray portion is subject to molecular adjustment, in a measure, by subsequent cooling methods. It would, therefore, seem that instead of splitting hairs with the element phosphorus, grave attention should be given the matter of carbon ratio and the indirect bearing of other elements which vitally affect carbon.

As a further illustration of the controlling effect of carbon on cast iron, reference may be made to specimen castings which are extreme to the analysis of car wheel. Not all foundry work will admit of a high combined carbon ratio. Stoveplate, pipe, radiator, enamelware and ornamental iron mixtures require a ratio of from 1:8 to 1:13 combined carbon to graphitic carbon, compared with ratio of from 1:3 to 1:4 for car wheels. That is, for a free-pouring, sharp iron the graphitic carbon should be approximately 3.25 to 3.10 per cent and combined carbon 0.25 to 0.40 per cent. Under these conditions the high graphitic carbon permits the iron to be superheated to a higher degree on account of the higher heat absorption necessary to melt the iron and put the graphitic carbon in solution; therefore, a more fluid iron results. Inasmuch as the specific heat of graphite or carbon is above 0.50 at high temperatures, the metal will remain fluid longer under this high specific heat and will cool more slowly. This is due to the fact that after solidification of the metal the graphite comes out of solution, or freezes out, thereby giving up heat by its chemical dissociation from the metal into a mechanical mixture of free carbon, or graphite. Carbon which remains in solution with the iron, as does combined carbon, has no heat of dissociation to give up. The reverse condition results in the melting and cooling of a white or mottled iron—a high combined carbon iron melts at a lower temperature than high graphitic carbon iron and sets at about the same temperature. Thus these are noteworthy differentiating characteristics of a white or mottled iron and a gray iron, and are directly controlled by the carbon ratio.

Stripping Match Plate Simplifies Work

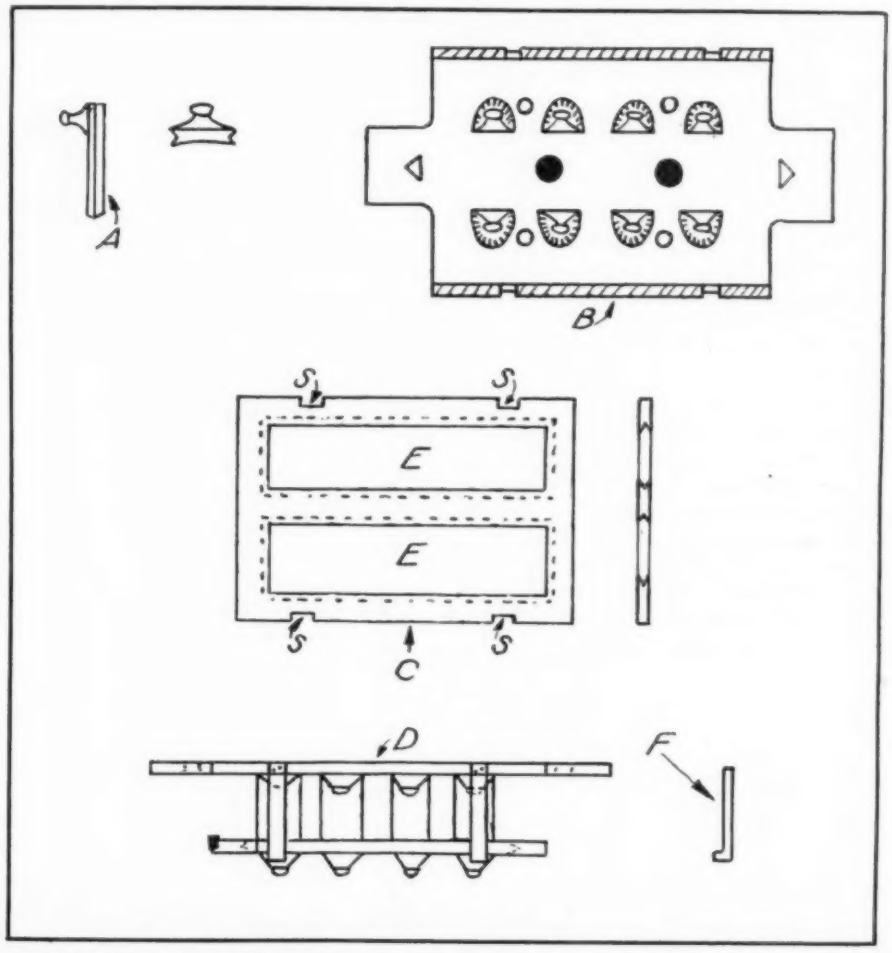
BY HAROLD DAVIS

The method adopted in making the stripping match plate shown in the accompanying illustration may be applied to many jobs of a like character either on the bench or on a machine. By adapting it to meet varying conditions many patterns, usually classed as intricate and difficult to make may be made successfully with a minimum of skill and effort. The casting selected for illustration is a feed cut off for a fertilizer distributor. It is 3½ inches long by 1½ inches wide, 7/16 inches thick, provided with a V-shaped groove on each edge and with a knob at one side near the end which later is attached to a lever for pulling it in and out. The grooves on the sides must be perfect, a feature which rendered the job difficult either when made by hand or on a plain match plate.

A master pattern was made ¼-inch longer than the required castings. This extra ¼-inch was designed to compensate for the thickness of the stripping plate. Eight aluminum patterns then were made and after they had been carefully filed and finished they were placed on a follow board and a mold made off them in the usual manner. However, the patterns were not drawn out of the sand as usually is the case when making a match plate. After the cope had been lifted off, the joint on the drag was built up for the desired thickness of plate, then the cope was returned to its place and the metal was poured in on top of the patterns to form the plate. The patterns afterward were riveted in place and the plate finished and fitted to the snap flask pins.

The stripping plate *C* was made the same length as the match plate, but ½-inch wider. The openings shown at *E* and *E* large enough to clear the cope lift all around were made with flat cores beveled at the edges to produce an interior V-shaped groove on all four sides. This plate was finished including the filing of four slots shown at *S*.

The match plate was set on the bench and a drag half of a mold rammed on it and rolled over. The match plate was lifted off the drag and set down temporarily while the stripping plate was being adjusted on the face of the drag mold. The patterns were then returned to their places and



THE SPACE *E E* SURROUNDING THE PATTERNS IS FILLED WITH BABBITT AND AFTERWARD FILED TO A NICE SLIDING FIT

pushed down until the match plate came to rest on the stripping plate. It was clamped in this position and then babbitt was poured through the holes shown in *B* until the spaces *E* and *E* were filled.

After the casting had cooled, the stripping plate was removed from the patterns and the various openings filed to make them a close sliding fit. Four light lift straps, *F*, were attached to the match plate as indicated at *D* and these serve to lift the stripping plate off the mold as soon as the match plate has been lifted high enough for the patterns to clear. It is not necessary to rap or vibrate the match plate and the job can now be made by the ordinary handy man where before it was necessary to employ a skilled molder.

Find Old Casting Used as Stove Plate

By John T. Goolrick Jr

In the possession of Val Dannehl, proprietor of Dannehl's Foundry and Iron Works, at Fredericksburg, Va., is an iron grave plate that Mr. Dannehl believes to be one of the oldest pieces of iron cast in America. The plate bears the inscription "B. Grymes 1758" and was probably cast in that year. Evidence is offered that it was made at the foundry of Governor Spottswood in the Wilderness section, Spotsylvania county Virginia. The old grave plate probably was removed from the grave of "B. Grymes" more than half a century ago and was reused as a back in an old stove in the residence of a farmer in the vicinity.

The work on the plate was rough, but the casting was much better when made than it is now after the wear and rusting of a hundred and sixty years. The inscription is still plain.

Governor Spottswood instituted in 1714 at Germanna, on the Rapidan river and near where the great civil war battle of the Wilderness was fought, a colony which worked the first iron mines in America. Ore from the deposits in the Wilderness was made into bars there, using pine charcoal for fuel, and was conveyed by ox drawn vehicles over a road cut through the forests to deep water on the Rappahannock river, 30 miles away, where it was loaded on vessels.

The iron works were conducted by the governor with capital furnished by himself and the leading men of Virginia, and the main settlement at Germanna was made up of German artisans brought from Müsen in Westphalia. The town consisted of a row of cabins with a central fort, all surrounded by a heavy palisade for defense against Indians.

OLD GRAVEPLATE REUSED IN FARMERS STOVE

Traces of the old working remain about Wilderness, and also near Fredericksburg where there is an old slag heap. Although the furnace produced fair iron and made good castings for the household, grates, ploughs, and most important, the pots in which all food was cooked in the days before stoves were invented, it failed financially and caused Governor Spottswood to lose most of his great fortune.

English and Australian Steel Firms Join

As a result of an association formed between the English steel manufacturing company, Hadfield's Ltd., Sheffield, and the Australian Electric Steel Co., Ltd., with a plant in operation in Sydney, New South Wales and a second plant in course of erection in Perth, Western Australia, a new company Hadfield's (Australia,) Ltd., has been registered. The company with a capital of £500,000 or approximately $2,000,000 at current exchange, will make extensive additions to both works with a view not only of increasing the output, but also to increase the range of manufacture to cope with the country's industrial development.

The Australian Electric Steel Co., Ltd., pioneers in the commonwealth in the manufacture of steel by the electric process, commenced operations in 1917 with a capital of £40,000. This was increased in 1919 to £160,000. The company has been uniformly successful and has built up an extensive business.

Recently, owing to the continued expansion of the business and the possibilities of future development it was considered advisable to increase the capital. Not only did it become advisable to increase the works, but it also was necessary to secure the assistance of some of the more experienced and older established steel makers to solve the many scientific and technical problems involved in the manufacture of high grade steel products. Both these objects were accomplished when J. M. Deschamps, founder and present managing director Australian Electric Steel Co., Ltd., recently visited England and was instrumental in bringing about the association between his company and Hadfield's, Ltd., Sheffield.

An interesting feature in connection with this industry and one that illustrates the policy of the Commonwealth government to make the country self supporting is the embargo placed on the exportation of scrap. Of all the raw materials available in Australia for the manufacture of steel castings, a supply of scrap steel is the most important. During the war efforts were made to send this material to the East and but for the foresight and protest of Sir John Higgins, metallurgical adviser to the government the growing steel industry might never have been established in Australia. The company anticipates being able not only to supply a large part of Australia's requirements, but also to do a substantial export trade with adjacent Far Eastern countries.

The board of directors of Hadfield's (Australia) Ltd., include: Sir Robert Hadfield, Bart., D.Sc.,D. Met.; John Melrose, Adelaide; Robert Oswald Law, Perth; Ludoric Blackwood, Sydney; and J. M. Deschamps, Sydney. Mr. Deschamps is managing director of the new company.

The first record of a brass foundry in Pittsburgh is found in a census of the industries of 1815.

THE FOUNDRY

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Make Haste Slowly

GENERALLY speaking, it may be said that few manufacturers will of their own accord go out to seek new processes while those in use prove satisfactory. Therefore, in introducing a novelty the course must be to apply first to those dissatisfied with results being obtained by previous methods of production. The cupola has been successful for melting gray iron and any process to displace it must show a decidedly lower melting cost or offer superior results. In introducing the electric furnace for melting or refining gray iron many advantages are claimed and if all of them would accrue with the adoption of this type of melting medium, the cupola soon would be obsolete in the gray-iron foundry. Unfortunately all the claims made for the electric furnace cannot be substantiated under all conditions. For example, the statement is made that iron at the spout can be obtained cheaper when the electric furnace is used than when melting in the cupola. This is unquestionably true in some rare instances where the cost of the charge can be materially reduced by the use of all steel scrap, and the price of coke is excessive while electric power can be obtained cheaply. In such cases the electric furnace has an opportunity to prove its value. Another opening for the electric furnace is where complicated castings are made and trouble is experienced when producing these castings with cupola iron. If electric furnace metal will lower the percentage of defective castings, in such a shop, to an extent which will more than compensate for any extra expense of the melting operation, whether it accomplishes this through lowering the sulphur or by heating the metal regularly to a definite temperature, the electric process will be justified. The metallurgist in such a plant will heartily favor the electric unit, but he cannot easily convince the foundryman who is operating a cupola and securing fairly good results that the introduction of the electric furnace will be a benefit. There always is the possibility when metal is poor that the foundryman did not operate his cupola as efficiently and correctly as might have been done or that the wrong grade of pig iron was used. Only when the cupola is handled in such a manner as to secure the best results can its work be compared with that of the electric furnace, and conversely, electric furnace melting cannot be judged correctly unless the unit is operated to the greatest advantage. This condition has not been attained for either the cupola or the electric furnace owing to lack of knowledge of the essentials to be obtained, either in the way of composition of metal, pouring temperature, or the effect of the gases on the metal. Until these points are more definitely settled more modest claims for both processes will help in clearing the situation. While the progress of the electric furnace in the foundry field may not be stimulated so strongly by this policy yet its ultimate growth in the gray-iron foundry field will be on a firmer basis and its real merits will be seen more clearly. With its introduction in more foundries, the accumulation of data regarding its operation, and the benefits to be secured by it, the growth of the electric furnace will be on a secure basis and fewer failures will be made. That the electric furnace has a distinct field in gray iron melting is not to be doubted, but its advantages should be weighed carefully in each individual case.

Trade Outlook in the Foundry Industry

FOUNDRY operations continue to show little evidence of marked improvement, the relation between the various classes of castings manufacture giving practically no variation during the past weeks. Nevertheless, business is growing better, and the sentiment expressed shows courage and confidence in the outcome. Greater attention is being given to reducing costs. Materials are purchased on a closer basis and efforts to find new outlets for castings produced are intensive. This latter activity has brought into force a price cutting movement that cannot but result disastrously unless steps are taken to get back to a sane and recognized basis.

Low Level Reached

In some widwestern cities, where competition is keen among gray iron jobbing foundries casting prices have been noted as low as 2.8 cents a pound. These prices were for production jobs upon which a large proportion of scrap could be utilized. However, other figures approximating these have been made where the cost of metal in the ladle would closely approach the price at which work was taken. In some instances these bids have been prompted by a desire to carry a portion of the overhead of the plant, which when idle would be greater than the loss assumed through ruinously low prices. Price levels for practically all classes of jobbing castings have dropped. The consumer has accepted this as an evidence of deflation, and as an absorption of losses on the part of foundries. The greatest difficulty for many shops will arise when returning activity with probable stiffening of material costs forces them to advance their rates to a level dictated by costs rather than the immediate and urgent needs for business at any price.

Prices of Raw Material for Foundry Use

CORRECTED TO NOV. 23

Iron		Scrap	
No. 2 Foundry, Valley	$22.50 to 23.00	Heavy melting steel, Valley	$14.25 to 14.50
No. 2 Southern, Birmingham	18.00 to 19.00	Heavy melting steel, Pitts.	14.00 to 14.50
No. 2 Foundry, Chicago	21.00 to 22.00	Heavy melting steel, Chicago	12.50 to 13.00
No. 2 Foundry, Philadelphia	21.80 to 22.40	Stove plate, Chicago	14.00 to 14.50
No. 2 Foundry, Buffalo	19.50 to 20.00	No. 1 cast, Chicago	15.00 to 15.50
Basic, Valley	19.00	No. 1 cast, Philadelphia	18.00 to 19.00
Basic, Buffalo	19.00 to 20.00	No. 1 cast, Birmingham	16.00 to 17.00
Malleable, Chicago	21.00	No. 1 cast, Buffalo	15.00 to 16.00
Malleable, Buffalo	20.50	Car wheels, iron, Pittsburgh	15.50 to 16.00
Coke		Car wheels, iron, Chicago	16.50 to 17.00
Connellsville foundry coke	$4.00 to 4.50	Railroad malleable, Chicago	14.50 to 15.00
Wise county foundry coke	5.75 to 6.00	Agricultural mal., Chicago	14.50 to 15.00
		Railroad malleable, Buffalo	13.00 to 14.00

Slow Pickup Apparent

Stove, furnace, radiator, pipe and sanitary-ware foundries continue to receive orders and operations are high for this period of the year. Large orders for cast iron pipe are not noted, but the aggregate tonnage of municipal orders, coupled with an unusually active demand from industrial users continues to supply the books of pipe plants. Demand for automotive castings, of course, is not heavy, but considering the general industrial situation, the outlook is hopeful. Truck sales are reported to be increasing, while in October the shipments of passenger cars exceeded for the first time the figure for the corresponding month last year. None of the automobile, truck or tractor plants has an excess of castings on hand, all having been forced to reduce inventories during the summer and fall. The automobile tire industry, which has grown to be a large consumer of castings is in a much more healthy condition. According to the *India Rubber Review*, the fall inventory shows only about 60 to 70 per cent as many tires in stock this year as in November last year. A reflex of the automotive situation is found in the increasing demand for machinery, fittings and supplies for extensive oil field and pipe line development now in progress. Foundries furnishing castings to this source are increasing operations.

Construction Needed

Admittedly, 1921 is falling behind in building construction, and except for some industrial lines, much extension is needed. According to a survey made by the *Engineering News-Record*, a better outlook is offered by developments during the past few months. Contracts awarded in September were the highest in value noted this year. Further, reducing the cost to a common basis, there has been practically the same amount of construction carried on this year as in 1920, although the cost has been about 25 per cent less than a year ago. Despite the hampering influence of uncertain building prices, a great amount of improvement has been made in heating plants, as is shown by the demand coming to foundries making heating equipment. Malleable and steel foundries have not participated in the benefits of the constructional demand. It has been stated that the malleable fittings used in equipping a two-story dwelling are less than 20 pounds in weight. Malleable foundry operations still are less than 30 per cent, although improvement is noted, particularly in railway requirements. Over 7000 freight cars have been purchased recently in the Chicago district, while bids have been received on 8000 and inquiries are pending on 7000 additional. The demand for locomotives also is increasing and recent inquiries for foundry equipment from locomotive shops presage increased activity. No appreciable reductions have been made in freight rates, and car loadings have dropped. The total for the week ending Nov. 5 was only 829,722 cars as compared with 952,621 cars for the previous week. Manufacturers of castings for farm implements report the worst conditions ever known. Low prices on farm products have wiped out the demand for farm machinery. One large western manufacturer reports that the fall harvesting, soil preparation and seeding was accomplished this year with fewer new implements than at any time in the past 20 years.

Nonferrous Prices

Nonferrous prices, based on New York quotations in the *Daily Metal Trade* for Nov. 23 follow: Casting copper, 12.62½c to 12.75c; electrolytic copper, 13.50c to 13.75c; lead, 4.65c to 4.70c; Straits tin, 29.50c; antimony, 4.50c to 4.60c; aluminum, No. 12 alloy, open market, 14.00c to 15.50c. Zinc is 4.65c, E. St. Louis.

Comings and Goings of Foundrymen

ARTHUR LUCIAN WALKER, professor of metallurgy in the school of mines, engineering and chemistry, Columbia University, New York, has been elected a member of the board of the Engineering Foundation, succeeding Dr. Joseph W. Richards, who died recently. Prof. Walker, who will represent the American Institute of Mining and Metallurgical Engineers on the Board of the Foundation, has been a professor of metallurgy at Columbia since 1908. In 1898 he invented the Walker mechanical casting machine which revolutionized methods used for casting copper into refined shapes, and which is now extensively used in all the copper producing countries in the world. In 1902 he invented a new system for electrolytic copper refining tank room arrangement, which has been installed in practically all copper refining plants built subsequent to 1902. As a consulting metallurgist specializing in copper, he has been connected with many large corporations. During 1917-1918 he was consulting metallurgist at large for ordnance in the war department.

I. Hall, managing director, Monometer Mfg. Co., Ltd., London, England, is in New York arranging for American representation in the manufacture and sale of furnaces.

John K. Klink, purchasing agent of the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., was elected burgess (mayor) of Pottstown, Pa., at the election on Nov. 8.

George Whetten, formerly connected with the Hess Steel Co., Baltimore, Md., is now in charge of roll sales for the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

P. T. Laws, assistant works manager of the United States Cast Iron Pipe & Foundry Co., Burlington, N. J., will make his headquarters in new offices opened by the company at 811 Dixie Terminal building, Cincinnati. Harold G. Henderson will be in charge of sales from that office.

R. O. Patterson, managing director, Smith Patterson & Co., Ltd., Blaydon-on-Tyne, England, has been elected president of the Newcastle branch of the Institution of British Foundrymen. Mr. Patterson has been a member of the general council of the Institution of British Foundrymen for some time. He is one of the most widely known foundrymen in the north of England. The Smith Patterson company make a specialty of rail chairs and other railway castings. Mr. Patterson visited the United States at the time of the Philadelphia foundry convention in 1919.

George K. Vail, general manager of Arthur G. McKee & Co., Cleveland, blast burnace and steel mill engineers, has resigned to become vice president of the Ohio Steel Foundry Co., Lima, O.

H. D. Beard, who formerly was connected with the Davis Sewing Machine Co., Dayton, O., has accepted a position with H Brewer & Co., Tecumseh, Mich., manufacturer of clay working machinery.

James E. Higgins having retired from the firm of Higgins & Co., Holyoke, Mass., brass founders, the business will be carried on in the future by Frank Williams under the name of the Williams Brass Foundry.

Fred E. Holtz, for two years a member of the sales force of the W. A. Jones Foundry & Machine Co., Chicago, has been appointed district representative of the company with headquarters in the First National bank building, Milwaukee.

R. A. Cannon, formery with the Reading Steel Casting Co., Reading, Pa., and previously to that with the Penn Seaboard Steel Co., Philadelphia, Pa., on Nov. 1 became associated with the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., as manager of iron and steel castings sales.

C. A. Peckham, president of the Toledo Bridge & Crane Co., Toledo, O,, has been elected a director of the Canadian Austin Machinery, Ltd., Woodstock, Ont., a new organization of which B. A. Linderman, president of the Linderman Steel & Machine Co., Muskegon, Mich., and John Ross Shaw, vice president of the Canadian Linderman Co., Ltd., Woodstock, are president and vice president, respectively.

James E. Higgins, for 18 years a member of the firm of Higgins & Co., Holyoke, Mass, brass founders, has leased a former foundry in Chicopee, Mass., and will conduct a general jobbing foundry business, beginning Dec. 1. Mr. Higgins recently retired from Higgins & Co., which firm is now known as the Williams Brass Foundry.

H. B. Harmer, safety department, Philadelphia Electric Co., and representing the Philadelphia Safety council, addressed the November meeting of the Philadelphia Foundrymen's association on "Safety with Relation to Accident Prevention in the Foundry, Machine Shop and in Trucking by Automobile and Horse."

Addresses Foundrymen On Pneumatic Tools

Pneumatic tools in their manufacture and use were attractively presented to the members of the Pittsburgh Foundrymen's association at their regular monthly meeting held at the General Forbes hotel, Pittsburgh, Nov. 21. Valuable points in the operation and care of such equipment in foundries were given by H. S. Covey, secretary and sales manager of the Cleveland Pneumatic Tool Co., Cleveland. Reading from his manuscript entitled "How Pneumatic Tools Are Made, Their Treatment in Service and How to Obtain Maximum Efficiency in Their Work," Mr. Covey described various air tools minutely even to pointing out the necessity of taking the moisture out of the line and the effect of various grades and kinds of oils on them. He told also of the loss in efficiency sustained in using a 3-inch as compared with a 1-inch line, and then by the aid of a 4-reel motion picture described in detail the manufacture of pneumatic tools. This film showed the continuous processes of manufacture from the forge shop, through the machine shop, down to the finished articles.

At this meeting, Treasurer William J. Brant of the Pittsburgh Foundrymen's association, who has been acting secretary since the death of the late Bayard Phillips, formally was appointed secretary by the executive committee

The Christmas meeting and entertainment of the organization will be held Dec. 19 at the General Forbes hotel. Past President A. J. Hartman, of the United Engineering & Foundry Co., Pittsburgh, was appointed chairman of the committee on activities, having in charge the preparation of the entertainment features for this gathering.

E. C. Humphrys & Brother, iron, fuel, sand and fire brick, have removed their general office to 502 Clinton building, Columbus, O.

Equipment Inquiries Show Increase

Greater Interest Evidenced in Molding Machines, Melting and Handling Machinery—Lighter Sundries and Supplies Also Indicate Slowly Reviving Buying Tendency

INTEREST in foundry equipment, as evidenced by the volume of inquiry is growing. Some of this, while admittedly based upon future anticipations, marks a hopeful tone in the market. A feature of the eastern situation is the pickup in activity among locomotive manufacturers. Electric furnace demand is showing signs of life, particularly in foreign inquiries and in the domestic interest in nonferrous melting units. The Metal Products Mfg. Co., Portland, Oreg. recently has been incorporated by W. W. Lucius, president and others, to engage in the manufacture of cast aluminum.

Inquiry Lively in Pittsburgh District

PITTSBURGH district foundries as yet are not ordering foundry equipment in sizable quantities, but inquiries are so numerous that sellers are more optimistic than they have been for many weeks. Most of these give promise of early closing and since they call for everything from flasks to cupolas, some foundry operators desiring blowers, ladles, core ovens, etc., the possibility is the coming month will bring about a whirlwind finish for the year in equipment circles. However, some tendency is noted to postpone buying until after the first of the year and it may be that most buyers will wait until after inventory-taking time to make their purchases. The American Foundry Co., Salisbury, N. C., which recently asked for considerable machine tool equipment likewise is in the market for a 3 or 4-ton per hour capacity cupola, a blower, tumbling barrel, brass furnace, several ladlles, and other foundry equipment. One house reports two sand mixers sold to users in Jeannette and Uniontown, Pa. The United States Sanitary Mfg. Co. bought five or six slag ladles, together with miscellaneous other ladle equipment. The American Locomotive Works, Dunkirk, N. Y., recently ordered four large Herman molding machines and the American Locomotive Works, Richmond, Va. now is negotiating for similar equipment. Other inquiries for molding machines are current and a few smaller sales are noted. Present orders for flasks are limited due to the fact that most foundries are well stocked up and while inquiring for more, are holding off on their purchases. Some inquiries for electric furnaces, air compressors, etc., have been held in abeyance for almost a year. Many of these are counted as being practically sold, but the buyers will not sign the contracts until their business improves. Crane sellers have a few inquiries to work on and in some directions, notably West Virginia, considerable expansion is planned for the spring which will mean additional crane inquiries as well as requests for other foundry machinery. The Pittsburgh Valve, Foundry & Construction Co. is understood to be in the market for a crane.

Light Equipment Demand Improves

IF ALL the inquiry coming from foundries to equipment manufacturers and dealers could be converted into sales business would be at the top notch. However, it appears that much of it is tentative and to feel out the market, only a portion resulting in sales. The interest manifested indicates that foundrymen are getting ready for the business that will come later. Selling to foundries is on the upgrade, each month seeing a better total than the preceding. Miscellaneous and special equipment is being taken in better volume. Ladles and light sundries are in demand. Two cranes have been placed recently with the Whiting Corp., Harvey, Ill. One of 10 tons was bought by the Michigan Stamping Co., Detroit and a 5-ton crane by the Indiana Fibre Co., Indianapolis. Construction work is dull, but engineers are

Occasional Purchases in the East

FOUNDRY equipment business in the east still consists largely in purchase of single machines. Few new projects are in contemplation, and action on those that have been recently reported, is slow. The American Locomotive Co. which has been figuring on the purchase of electric furnaces for a plant at Chester, Pa., has been unable to make satisfactory arrangements for electric power and has decided to install heating units of a different character. It also is understood that additional equipment is to be purchased for this plant. The Florence Pipe Foundry & Machine Co., Florence, N. J., is making alterations to its plant and is inquiring for a 40-ton and a 10-ton handpower crane with span of 57 feet, 10 inches. The International General Electric Co., Schenectady, N. Y., is inquiring for some equipment, including a small electric furnace for a foundry in France. The East Jersey Pipe Co., 7 Dey street, New York city, recently in the market for three 10-ton cranes with 25-foot span and five 3-ton cranes with 60-foot span, has withdrawn from the market. The company was figuring on a contract, the award of which would have necessitated the erection of a steel foundry. The Gray Iron Foundry Co., Reading, Pa. plans to increase its line of production to include axes, hammers and other hardware.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

Addition of a specialty manufacturing department and the taking over of H. A. Blake & Son, Cheboygan, Mich., operators of a foundry and machine shop, is the purpose of the organization recently of the H. A. Blake Machine & Foundry Co. with a capital stock of $50,000. The new company will consolidate the properties of H. A. Blake who died several months ago. No new buildings are

contemplated at this time. Officers of the company are: President, F. S. Ritter; vice president, Jessie Blake; secretary, John A. Blake and treasurer and general manager, William H. Blake.

The Chicoutimi Pulp & Paper Co., Chicoutimi, Que., plans to rebuild its foundry which was recently damaged by fire.

S. Cheney & Sons, Seneca street, Manlius, N. Y., maker of iron castings, etc., is reported planning the erection of a plant building.

The H. S. & W. B. Cochrane Corp., Seventeenth street, Philadelphia, plans the erection of a 1-story plant building addition.

The Floyd-Wells Co., Royersford, Pa., manufacturer of heaters, stoves, etc., plans the erection of a plant addition, 32 x 120 feet.

Contract for the erection of a foundry building recently was awarded by the Oregon Brass Works, North Second street, Portland, Oreg.

The Tipps Foundry & Machine Co., Austin, Tex., plans to rebuild the portion of its plant which was recently damaged by fire.

The J. S. Heath Co., Franklin and Ontario streets, Chicago, will move shortly into its foundry, machine shop and plating shop, now under construction at Waukegan, Ill.

Capitalized at $100,000, the Delaware Car & Tractor Co., Muncie, Ind., recently was incorporated by M. T. Hanley, F. A. Hanley and Bennett Heath.

C. B. Babcock & Co., 768 Mission street, San Francisco, are erecting a modern factory building, which will be utilized for the manufacture of gas furnaces, etc.

Reports are current to the effect the Pittsburgh Malleable Iron Co., Pittsburgh, has plans under consideration calling for the erection of a 1-story building.

Plans are reported under consideration by the Standard Sanitary Mfg. Co., Pittsburgh, for the erection of a modern foundry, 145 x 180 feet, at New Brighton, Pa.

To operate foundries, machine shops, etc., the Enterprise Foundry Co., Los Angeles, recently was incorporated in California with a capital stock of $100,000.

A site has been purchased by the J. T. Tice Co., La Grange, Ga., on which it plans the erection of a machine shop and foundry, the main building to be 75 x 175 feet.

Work has been started by the Plainville Casting Co., Plainville, Conn., on the erection of a modren foundry building, 60 x 145 feet, which is being built on a site adjoining the company's present plant.

The Standard Piston Ring Co., Weatherford, Tex., recently was incorporated to manufacture piston rings, etc., with a capital stock of $10,000, by H. J. Bradfish, G. S. White and M. D. Akard.

Mongeau & Roberts, Ltd., Montreal, Que., have been incorporated to manufacture and deal in copper, brass, iron, steel, etc., with $99,000 capital stock, by Joseph Mongeau, Achille Roberts, Jules Bourgouin and others.

Lubri-Gaiters, Ltd., Montreal, Que., recently was incorporated to engage in business as iron founder, etc., with a capital stock of $100,000, by G. C. Papineau-Couture, Edmund P. D. Harris and Margaret Hartley.

The Brass & Bronze Mfg. Co., Ltd., Montreal, Que., recently was incorporated with a capital stock of $50,000, to engage in the manufacture of copper, brass, bronze, etc., by Walter A. Merrill, Archibald Stalker, Jean L. Muir and others.

Capitalized at $100,000, the Fulton Foundry & Machine Co., Brooklyn, N. Y., recently was incorporated by A. W. Mesick, G. W. Van Eps and F. W. Baldwin. The company is represented by Watson, Kristeller & Swift, 68 William street.

To engage in a general foundry and machine shop business at 52 East Galena street, Freeport, Ill., the Schwartz Mfg. Co. recently was incorporated in Illinois with a capital stock of $100,000. The incorporators of the company are Carl H. Schwartz, Russel Jungeblut, D. F. Graham, Edwin Hall, John A. Ascher, A. J. Clarity, D. F. Grant, Addison Bidwell, W. L. Karcher and S. L. Young.

The Coy Valve Co., Inc., Seattle, plans to erect a large plant. Work is expected to be started on the first unit within 60 days and it is expected the plant will be ready for operation in six months. W. Graham is manager of the company.

The Holland Brass Works, Inc., 616 West Monroe street, Chicago, recently was incorporated with a capital stock of $40,000, to engage in a general brass and iron foundry and machine shop business, by Frank B. Liska, B. F. Liska and William F. Liska.

To make brass and bronze castings, the Quinnipiac Foundry, Inc., New Haven, Conn., recently was incorporated with a capital stock of $5000. Incorporators of the company are A. B. O'Keefe, L. J. Clawson and W. M. Higgins, of Hamden, Conn.

The Alena Steam Products Co., Indianapolis, has obtained a factory site of 6 acres, on which it plans the erection of a modern manufacturing plant. The company will manufacture steam trucks and tractors. Fred Hamilton is president and John W. Cadie, secretary and treasurer of the company.

The plant of the Bowie Stove Works, Rome, Ga., which recently was damaged by fire, will be rebuilt at once, according to John M. Berry, an official of the company. The new plant will be larger and employ more men. The company's name also will be changed to the Rome Range & Stove Co.

The general contract for the construction of the new plant of the Oshkosh Tractor Co., Oshkosh, Wis., has been let to the Badger Concrete Construction Co., Oshkosh. Foundations are completed. The main building will be 152 x 380 feet with sawtooth roof and a wing, 30 x 100 feet.

Improvements which will represent an investment of approximately $200,000, are to be made at once at the Huntington, W. Va., plant of the American Car & Foundry Co., according to a recent announcement by W. H. Woodin, president of the company.

The Reed-Prentice Co., Worcester, Mass., is to immediately reopen its Gold street foundry, formerly the F. E. Reed Foundry Co., on account of the sale of the foundry of the Whitcomb-Blaisdell Machine Tool Co., where its castings have been made for several years. The Reed-Prentice foundry will make castings for both companies.

The Haynes Tractor Co., Kokomo, Ind., which recently took over the plants of the Holton Tractor Co., Indianapolis, and the Powell Tractor Co., Elwood, Ind., has been incorporated with a capital stock of $1,000,000. Officers are: President, Elwood Haynes, president of the Haynes Automobile Co.; vice presidents, Alton G. Seiberling and George J. Marott; secretary and general manager, John Powell, and treasurer, Marsh Haynes.

A group of experienced foundrymen have organized the Lincoln Foundry Co., at Merrill, Wis., to engage in the manufacture of cast iron, semisteel, brass, bronze and aluminum castings. Edward Heldt, for 20 years connected with Wisconsin and Minnesota shops is general manager of the new company. A plant is now under construction. It will be 30 x 90 feet, with one cupola and two brass furnaces. The cupola will be ready for operation about Dec. 15 and the remaining furnaces Jan. 1. Other buildings will be erected in the spring. The site of the plant is 200 x 600 feet.

Agreements have been signed for the sale of the property of the Standard Foundry Co., Worcester, Mass., to the Crompton & Knowles Loom Works of that city, and the transfer of the foundry property of the Whitcomb-Blaisdell Machine Tool Co. to the Standard Foundry Co. The Standard company had contemplated erecting a large plant on Stafford street in Worcester, but with the acquisition of the Whitcomb-Blaisdell foundry, which will enable the Standard company to double its capacity, the construction plans have been abandoned. The Standard foundry is adjacent to the loom works and the addition will permit the Crompton & Knowles company to make all of its own castings. Crompton & Knowles officials have been financially interested in the Standard Foundry Co., a $40,000 organization, of which Charles F. Hutchins is president and treasurer. Castings for the Whitcomb-Blaisdell Machine Tool Co., the Reed-Prentice Co., and the Becker Milling Machine Co., Hyde Park, Mass., which have been made at the Whitcomb-Blaisdell foundry will in the future be made at other foundries owned by these interests.

New Trade Publications

PNEUMATIC TOOLS—The Chicago Pneumatic Tool Co., New York, is circulating a 4-page illustrated folder in which pneumatic tools are described and illustrated. These include riveting hammers, drills, grinders, boring machines, etc.

EXCAVATING MACHINERY — An illustrated 24-page booklet has been published by the Marion Steam Shovel Co., Marion, O., in which excavating machinery, such as steam shovels, dredges, etc., is described and illustrated. The book deals principally with shovels most in use by road and general contractors. Specifications of the various types of equipment are given, and the illustrations show the shovels in operation.

ELECTRIC CRANE—The Northern Engineering Works, Detroit, is circulating a 4-page illustrated folder in which electric traveling cranes for foundry service are described and illustrated. All operating parts of these cranes are enclosed, protecting them from dust and heat. These cranes are made in single trolley design, from 3 to 75 tons, and in double trolley design to 150 tons, for any span and lift. They may be equipped with either direct or alternating current equipment. The illustrations show a number of actual illustrations.

TIMING INSTRUMENTS—The Stromberg Electric Co., Chicago, is circulating a 4-page illustrated bulletin in which a timing and signalling instrument is described and illustrated. This instrument is for use in all manufacturing processes where the element of time is a factor, such as in the heat treatment of steel and rubber, molding insulating materials, and for enameling, tanning, plating, etching, preserving, baking, etc. The instruments do not contain clock mechanisms or other delicate parts. They are connected to any alternating current circuit and with mechanical precision indicate the total length of the process, the length of time a process has been in operation, and automatically operate a signal when the process is completed. Full details are given.

PRESSURE RECORDERS—An 8-page illustrated booklet is being circulated by the Bacharach Industrial Instrument Co., Pittsburgh, in which pressure recorders are described and illustrated. Standard equipment consists of a cylindrical vessel or tank partly filled with water. The pressure to be measured is transmitted to the instrument and acts upon a bell float. The interior of the bell float communicates through a pipe with the gas main, flue, stack, or the airway, in which the pressure or draft is to be measured. The recording mechanism is mounted on top of the tank and consists of a drum for holding the chart and a specially designed clock. A pen rod is fastened to the bell float, and the pen which is pivoted at the top of the rod has a cup containing ink for marking the position of the float on the graduated chart.